Welch Allyn

Service Manual

Tycos Instruments Co., Inc. "New Valve" Style Ambulatory Blood Pressure Monitor (ABPM)

Medical Division
4341 State Street Road, P.O. Box 220
Skaneateles Falls, NY 13153-0220

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SERVICE MANUAL

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Ambulatory Blood Pressure Monitor
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Revision History

Revision	Date	Author	Description
1.00	2/16/96	JDB	Introduction of New Valve Manual.

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CHAPTER 1:

Overview of Manual

Chapter 1: Overview of Manual

1.1 QUICK REPAIR MANUAL DIRECTIONS

The following QUICK INSTRUCTIONS for the use of this manual are intended for the experienced and qualified repair technician who is familiar with both the ABPM and this manual. In particular, the repair technician must be certain that his/her repair, service, and test equipment meet the requirements stated in this document.

NOTE 1: COMPLETE A UNIT DATA SHEET FOR EVERY UNIT REPAIRED/SERVICED/TESTED (SEE APPENDIX 9.1)

NOTE 2: EVERY UNIT SHOULD BE CHECKED FOR PROPER HARDWARE AND SOFTWARE VERSION (SEE CHAPTER 8)

IF ABPM UNIT IS RETURNED FOR REPAIR:

A) IF UNIT PROBLEM IS UNKNOWN:

1. TEST FAULTY UNIT WITH THE FUNCTION TEST PROCEDURES IN CHAPTER 7 TO DETERMINE UNIT PROBLEM.

B) IF UNIT PROBLEM IS KNOWN:

1. GO TO CHAPTER 3 AND FIND PROBLEM IN UNIT PROBLEM LIST.
2. GO TO CHAPTER 4 AND FIND POSSIBLE COMPONENT FAILURES FOR CORRESPONDING PROBLEM.
3. GO TO CHAPTER 5 AND PERFORM COMPONENT DIAGNOSTIC TESTS UNTIL FAULTY COMPONENT IS DETERMINED.

C) IF FAULTY COMPONENT IS KNOWN:

1. GO TO CHAPTER 6 AND PERFORM COMPONENT REPAIR PROCEDURE.

D) AFTER UNIT IS REPAIRED:

1. GO TO CHAPTER 7 AND PERFORM ALL NECESSARY UNIT FUNCTION TESTS AND CONFIRM THAT REPAIRED UNIT MEETS PRODUCT SPECIFICATIONS (SEE DOCUMENT 126P152).

IF UNIT IS RETURNED FOR SERVICE:

1. GO TO CHAPTER 8 AND FOLLOW UNIT SERVICE PROCEDURES.
2. GO TO CHAPTER 7 AND PERFORM ALL NECESSARY UNIT FUNCTION TESTS THAT APPLY AND CONFIRM THAT SERVICED UNIT MEETS PRODUCT SPECIFICATIONS.

1.2 Statement Of Repair Manual Scope

This manual is intended solely as a reference for repair and service of the "new valve" version of the Tycos Instruments Ambulatory Blood Pressure Monitor. The ABPM model refers to both the QuietTrak (Catalog #'s 5100-11, 5100-12, 5100-13, 5100-14, & 5100-15) and the Tenso24 (S&K Catalog #55-68-189). Repair and service of the ABPM is to be performed at repair centers and by repair technicians qualified by the Tycos Instruments Quality Assurance Group. Equipment used for ABPM repair and service must meet or exceed the equipment/tool specifications provided in Appendix 9.6 of this document. Repair and test equipment used for the procedures in this manual must be maintained and calibrated per the standards described in Section 2.4 of this document. In addition, this document must be maintained with all addenda and modifications provided by Tycos Instruments. Welch Allyn and Tycos Instruments claim no responsibility for any damage or loss due to actions taken outside of the above stated scope and the procedures and specifications stated in this document.

1.3 Overview of Ambulatory Blood Pressure Monitor (ABPM)

The ABPM is designed for use as a battery-powered portable medical blood pressure recording device. The operating portion of the unit consists of the base unit, an external pneumatic assembly with microphone, and an occluding arm cuff (with bladder). The physician programs the unit to measure and record the patient's blood pressure values at designated intervals over a specified 24 hour interval or until the batteries run down or the unit's data limit is reached. The pneumatic assembly and microphone are attached to the occluding arm cuff. The microphone and arm cuff are adhesively attached to the patient's arm. The pneumatic assembly and microphone connect to the base control unit which is either attached to a belt around the patient's waist or to a strap across the patient's shoulder.

The unit operates by inflating the occluding cuff until blood flow in the arm is stopped. Systolic blood pressure, diastolic blood pressure, arterial pulse pressure, and heart rate are determined by slowly deflating the cuff while recording and processing the auscultatory signals recorded by the microphone attached to the patient's arm. The unit retries the measurement cycle if it does not detect a signal or if it determines the recorded blood pressure values to be out of the programmed range. Patient data can be displayed on the unit, printed to an externally connected printer, and transferred to a connected personal computer (PC).

The "new valve" version of the ABPM is designated at Tycos by production document 124S536*. (* Indicates language and model: E = English QuietTrak, S= Spanish QuietTrak, F= French QuietTrak, G=German QuietTrak, I=Italian QuietTrak, K=Tenso24).

1.4 Overview Of Repair Manual Format

This manual is designed as a reference tool to assist a trained repair technician in diagnosing and repairing malfunctioning ABPM units. It is presumed that the repair technician will be familiar with all ABPM components, ABPM assembly methods, and ABPM user operations. Necessary reference documents are provided in the Appendices of this document and a list of additional ABPM documents are listed in Appendix 9.7.

Chapter 1 is an overview of this repair manual. It defines the intended use, limitations, and outline of this repair manual. It also provides a brief overview of the ABPM unit and operation.

Chapter 2 lists the equipment required for repair, service, and test of the ABPM. The test equipment is for diagnosing unit component failures and testing a unit's operation after repair or servicing. The repair and service equipment are needed for repairing or servicing a unit. Replacement unit components are listed in Appendix 9.6.

Chapter 3 is a comprehensive guide to possible unit problems. **This should be the entry point for the repair technician when repairing a unit.** Once the correct unit problem is determined, the repair technician should refer to Chapter 4 to determine the possible component failures for the particular unit problem.

Chapter 4 provides a list of possible failed components for the different unit problems.

Chapter 5 describes diagnostic test procedures to determine if a unit component has failed.

Chapter 6 describes the repair and replacement procedures for failed unit components.

Chapter 7 describes the unit functional test procedures necessary to certify a unit's complete and proper operation after completion of either service or repair.

Chapter 8 describes service procedures for upgrading a unit with any post-assembly hardware or software modifications.

Chapter 9 is a collection of Appendices that contain necessary reference documents and drawings associated with the ABPM repair, service, and test procedures in this document.

1.5 Description Of Symbols Used

ABPM : Ambulatory Blood Pressure Monitor

A/D : analog to digital converter, used to change analog measurements into digital information

cc : cubic centimeters (unit of volume), used in ABPM test specifications

cm : centimeters, standard measuring unit of length

CPU : central processing unit (control device for ABPM)

EEPROM : see ROM

LCD : liquid crystal display (display device for ABPM)

mA : milliAmperes, standard measuring unit of electrical current

mm : millimeter, standard measuring unit of length

mmHg : millimeters of mercury, standard measuring unit of pressure (used with ABPM measurements)

mV : millivolts, standard measuring unit of electrical voltage

PC : Personal Computer or microcomputer

PCB : printed circuit board (ABPM circuitry contained on two PCB's)

POST : Power On Self Test (the ABPM's startup software check routine)

RAM : Random Access Memory (data storage device for ABPM)

ROM : Read Only Memory (data storage device for ABPM control software)

RTC : Real Time Clock (time measuring circuit for ABPM)

VDC : direct current voltage

Vpp : peak to peak voltage, unit of measure for oscillating voltage signals

WDT : watchdog timer circuit (ABPM WDT checks for proper operation of unit software)

CHAPTER 2:

ABPM
Repair/Service/Test Equipment

Chapter 2: ABPM Repair/ Service/ Test Equipment

2.1 Scope Of Repair/Service/Test Equipment

The repair/service/test equipment described in this chapter are those items required for completing all of the repair, service, and test procedures described in this manual. Any repair and test equipment used to perform any of the procedures in this repair manual should meet, exceed, or be functionally equivalent to the requirements of the specifications provided in Appendix 9.6. All repair and test equipment listed in this chapter must be maintained and calibrated with appropriate standards traceability as designated in Section 2.4 of this chapter.

This repair manual is designated for the "new valve" version of the Tycos ABPM manual. The "new valve" version of the ABPM (both QuietTrak and Tenso24 units) are designated at Tycos by production document 124S536* (* Indicates language and model: E = English QuietTrak, S= Spanish QuietTrak, F= French QuietTrak, G=German QuietTrak, I=Italian QuietTrak, K=Tenso24).

The repair and test equipment and tools described in this chapter are either items commercially available in the United States, custom repair tools available from Tycos Instruments, or replacement unit parts available from Tycos Instruments. Appropriate sources for each item in this chapter are provided with the specifications in Appendix 9.6.

2.2 List Of Repair/Service/Test Equipment

The following is a three part list containing sections for unit test equipment, unit repair equipment, and unit replacement parts (specifications provided in Appendix 9.6):

(Unit Test Equipment)

1. **Calibrated Pressure Sensor - Setra Meter model 2003 (0-10 psig)**
2. **Calibrated Timer (Stopwatch/Digital Timer) - 8456T12**
3. **Calibrated Adjustable Isolated Power Supply**
4. **Custom Battery Insert - T-112372**
5. **Calibrated Voltage And Current Measurement Device (2 DMMs)**
6. **Personal Computer (PC) - 386 20 MHz IBM compatible or better.**
7. **Custom Serial Communication Cable - T112371**
8. **Calibrated 100 cc, 250 cc, 500 cc Volumes - T-112819,112818, and 112854**
9. **Bulb With Valve - 5088-01**
10. **Pneumatic Hosing - 97P24**
11. **Pneumatic 'T' and 'Y' Connectors - ***
12. **Miniature Flat Head Screwdriver - ***
13. **Grounded Bench Mat With Personal Grounding Strap - T-112469**

*** - T numbers TBD.**

(Repair Equipment)

14. **Torque Limiting Driver - T-112467**
15. **Torque Limiting Driver - T-112466**
16. **Torque Limiting Driver - T-112459**
17. **Front Housing Nest - T-112064**
18. **Front Housing Locator - T-112089**
19. **Battery Housing Nest - T-112066**

20. Keypad Post Engaging Tool - T-112067
21. Serial Port Assembly 11 mm Wrench - T-112068A
22. Bumper Installation Tool - T-112069
23. Microphone Port Assembly 6 mm Wrench - T-112068
24. Wire Cutters - T-112486
25. Needle Nose Pliers - T-112458
26. Foam Swabs - 318M2
27. Tweezers - T-112511

(Replacement ABPM Parts)

1) 114P81	Battery, 15 V AAA (German Size Micro AM4)
2) 5100-30	Microphone and Pneumatic As
3) 95P336E	Patient Diary, English
4) 95P337E	Manual, English
5) 95P338E	Card, Owner Reg
6) 5100-52	Medium inflation bladder
7) 5100-53	Large inflation bladder
8) 5100-38	Medium cuff
9) 5100-37	Large cuff
10) R35S677E,F,G,S,I	QuietTrak Rear housing ass.
11) R3S608	Battery door assembly
12) R168S102	Pump
13) R45P3280	Label, battery insulator
14) R11P1234	Spring, battery contact
15) R66S508	Serial Port Receptacle Assembly
16) R430E142	Tubing, Silicone
17) R121S103	Valve, Dump
18) R121S104	Valve, Control
19) R66S507	Microphone Receptacle Assembly
20) R116S179	LCD module
21) R114P82	Battery, lithium
22) R74P100	Switch array
23) R66S505	Flat cable - 6 inch, 14 conductor
24) R66S510	Flat cable - 6 inch, 18 conductor
25) R66P801	Connector, Dupont, 6-pin
26) R59P585	Bumpers
27) R43P821	Gasket, manifold
28) R35P1357	QuietTrak Housing, front (black)
29) R35P1353	Housing, battery
30) R35P1352	Housing - battery cover
31) R11P1235	Spring - battery door
32) R9P2458	2-56 x .188 screw
33) R9P2849	2-28 x .50 screw
34) R9P2842	2-28 x .312 screw
35) R9P2841	0-40 x .188 screw
36) R4P436	Manifold
37) R45P3244	Battery label
38) R125S206	Power supply PCB (>= Rev. B)
39) R125S205	Main PCB (>= Rev. C1)
40) R34P767	LCD Window
41) 265E388	Black wire
42) 430E135	Shrink tubing

43) R78P564	Pad, Foam
44) R78P565	Disc, Foam
45) R78P566	Strip, Foam
46) R113P461	Small grd. lug
47) R113P462	Large grd. lug
48) R35P1365G	Tenso24 Rear Housing (gray)
49) R35P1357G	Tenso24 Front Housing (gray)
50) R55-70-930	Tenso24 Accu-pack mount
51) R114S589	Pressure Sensor (on Main PCB)

(ABPM Accessory Items)

Patient Hook up kit

1) 5100-41E	(English)
2) 5100-41F	(French)
3) 5100-41G	(German)
4) 5100-41I	(Italian)
5) 5100-41S	(Spanish)

Patient Diary

6) 5100-42E	(English)
7) 5100-42F	(French)
8) 5100-42G	(German)
9) 5100-42I	(Italian)
10) 5100-42S	(Spanish)
11) 5100-43	Microphone anchors
12) 5100-44	Cuff anchors
13) 5100-45	Anchoring straps
14) 5100-46	Carrying pouch
15) 5100-47	Waist belt
16) 5100-48	Shoulder strap
17) 5100-49	T-Connector
18) 5100-30	Micro/pneum tubing as
19) 5100-31	Large cuff/pneum. as
20) 5100-32	Medium cuff/pneum as
21) 5100-33	Small cuff/ pneum. as
22) 5100-34	Large cuff and bladder
23) 5100-35	Medium cuff and bladder
24) 5100-36	Small cuff and bladder
25) 5100-37	Large cuff
26) 5100-38	Medium Cuff
27) 5100-39	Small cuff
28) 5100-51	Small bladder
29) 5100-52	Medium bladder
30) 5100-53	Large bladder
31) 5100-25	PC Cable
32) 5100-22	Printer Cable
33) 5100-6X	PC Diskette SW

*** ACCESSORY items are packaged for sale to customers also.**

All of the above parts can be ordered from Tycos Instruments.

NOTE

This list does not include any parts or equipment used for shipping, such as poly bags, cartons, foam blocks, heat sealers, etc.

2.3 Description Of Repair/Service/Test Equipment

The following sections describe the individual functions of the repair, service, and test equipment listed in Section 2.2. Unit replacement parts are not described.

2.3.1 Calibrated Pressure Sensor

Used to determine air pressure of unit manifold when testing unit pneumatics. Allows for the diagnosis, testing, and service of unit pneumatic system; including proper operation of unit valves, proper operation of unit pump, and proper calibration of unit pressure sensor. (Setra Meter 2003 (0-10 psig))

2.3.2 Calibrated Timer (Stopwatch)

Used for timing unit valve and pump operations during functional test procedures. Time measurement is necessary to determine whether a unit function meets the product specifications in Document 126P152.

2.3.3 Calibrated Adjustable Isolated Power Supply

Provides simulated battery power to unit through the custom battery insert. This allows for operation of the unit with the battery door removed (which is usually the condition whenever the UNIT case is opened). Standard unit operating voltage is 6 VDC, with operating current requirements from 4mA to 1 A. Unit testing requires a voltage range from 0 to 6 VDC. If properly equipped with an adequate current readout, the power supply can provide testing needs for measuring unit current draw in different operating modes. Power supply output must be isolated from earth ground to simulate battery operation.

2.3.4 Custom Battery Insert

This molded insert available from Tycos provides an electrical power connection between the adjustable power supply and the unit. It is keyed in such a manner that it can only be inserted one way. There are no means for fastening the insert in place during test or diagnosis operations, so repair personnel must be careful not to move it during unit testing to avoid disconnecting the unit power.

2.3.5 Calibrated Voltage And Current Measurement Device

Used for calibrating unit pressure sensor, checking unit digital supply, checking unit current draw (if the adjustable power supply does not have current read back), performing power supply and main PCB board tests, and reading the calibrated pressure sensor.

2.3.6 Personal Computer (PC)

The PC provides a serial communication link to the unit. Software and instructions on use will be provided by Tycos Instruments.

2.3.7 Custom Serial Communication Cable (T112371)

This custom cable (Tycos Tool T112371) primarily connects the unit to the test equipment PC to allow for serial communication with the unit. The cable will have break out terminals for programming the units EEPROM.

2.3.8 Calibrated 100 cc, 250 cc, and 500 cc Volumes

These volumes (Tycos Tools T112818, T112819, T112854) are connected pneumatically to both the test pressure sensor and the unit using latex hose and pneumatic 'T' and 'Y' connections. These volumes are designated by the unit specifications in Document 126P152 for pneumatic unit functional testing.

2.3.9 Bulb and Valve

A bulb and valve (5088-01) will be used as the air pressure source required to inflate and maintain the unit pneumatic system and associated pneumatic test equipment at levels from 0 to 350 mmHg. The source must provide clean air so as to avoid introducing particulate matter, oil, or other foreign substances into either the unit or test equipment.

2.3.10 Pneumatic Hosing

97P24 - 5 3" pieces as well as a 2" , a 4", a 15" and a 10" piece are needed to connect all the test pneumatics, including the calibrated pressure sensor, the calibrated volumes, the test air pressure source, and the unit pneumatic assembly.

2.3.11 Pneumatic 'T' and 'Y' Connectors

These 'T' and 'Y' connectors are needed to provide pneumatic connections for the unit pneumatic test setups.

2.3.12 Miniature Flat Head Screwdriver

Needed to adjust the unit pressure sensor potentiometers located on the main PCB inside the unit. Adjustment may be required when re-calibrating the unit pressure sensor (see Section 8.2).

2.3.13 Grounded Bench Mat With Personal Grounding Strap

This equipment is needed to protect internal unit electronics from electro-static discharge (ESD) during internal diagnosis.

(Repair Equipment)

2.3.14 Torque Limiting Driver - T-112467

Needed for disassembly and assembly of the unit in order to perform diagnosis and repair of internal parts.

2.3.15 Torque Limiting Driver - T-112466

Needed for disassembly and assembly of the unit in order to perform diagnosis and repair of internal parts.

2.3.16 Torque Limiting Driver - T-112459

Needed for disassembly and assembly of the unit in order to perform diagnosis and repair of internal parts.

2.3.17 Front Housing Nest

Custom tooling fixture used to hold front housing during internal assembly.

2.3.18 Front Housing Locator

Custom tool needed for positioning LCD window and module during unit assembly.

2.3.19 Battery Housing Nest

Custom tool needed to hold battery housing during unit assembly.

2.3.20 Keypad Post Engaging Tool

Custom tool needed for engaging keypad posts to internal power supply PCB during unit assembly.

2.3.21 Serial Port Assembly 11 mm Wrench

Needed for fastening serial port assembly to inside unit housing.

2.3.22 Bumper Installation Tool

Needed for inserting bumpers into unit rear housing.

2.3.23 Microphone Port Assembly 6 mm Wrench

Needed for fastening microphone port assembly to inside of unit housing during assembly.

2.3.24 Wire Cutters

Needed for cutting wire for the use in the serial and microphone ports.

2.3.25 Needle Nose Pliers

Needed to pinch pneumatic hoses during unit pneumatics diagnostics and also to handle small internal unit parts during diagnostic tests and replacement procedures.

2.3.26 Cotton Swabs

Needed for removing oil, dust, and other foreign material from unit parts and surfaces during assembly.

2.3.27 Tweezers

Used for holding small parts during unit re-assembly.

2.4 Equipment Maintenance/Calibration Requirements

Listed below are the repair/service/test items that require periodic calibration certification in order to validate this manual's procedures when performed on any unit with the equipment. The calibration must be traceable to the standard measurements of the United State's National Institute of Standard Technology (NIST) or the foreign equivalent (Germany - NSAI, PTB, IEC). The calibrations performed must be to the accuracy specifications provided in Appendix 9.6 for each piece of equipment listed below. The interval between calibrations are listed beside each piece of equipment below. A calibration record must be maintained for each calibrated piece of equipment.

1. Calibrated Pressure Sensor	**(every 12 months)**
2. Calibrated Timer (Stopwatch)	**(every 12 months)**
3. Calibrated Adjustable Isolated Power Supply	**(every 6 months)**
4. Calibrated Voltage And Current Measurement Device	**(every 6 months)**
6. Calibrated 100 cc, 250cc and 500 cc Volumes	**(every 24 months)**
7. Torque Limiting Driver - T112467	**(every 12 months)**
8. Torque Limiting Driver - T112466	**(every 12 months)**
9. Torque Limiting Driver - T112459	**(every 12 months)**

In addition to the hardware listed above, all of the other repair/service/test items should be maintained with standard laboratory and manufacturing practices to insure proper operation.

This repair manual and equipment are required to be up to date and consistent with any changes or revisions to relevant ABPM component or operating modifications. Tycos Instruments will be responsible for providing updated versions of this repair manual, the unit control software, the unit testing specifications document (Document 126P157) to every registered ABPM service center. It will be the responsibility of the ABPM service center to properly implement any changes resulting from the updated repair manual and testing specifications.

CHAPTER 3:

Guide To Possible Unit Problems

Chapter 3: Guide To Possible Unit Problems

Chapter 3 contains a comprehensive list of possible unit problems broken down into the following two major classifications:

NOTE: Unit software and hardware version need to be upgraded to proper version per Chapter 8.

1. **Unit Operational Problems (see Section 3.1)**
2. **Unit or Pneumatic Assembly Is Physically Damaged/Discolored (see Section 3.2)**

If the unit problem is operational, consult the list in Section 3.1. If the unit problem is physical damage or discoloration, consult the list in Section 3.2

3.1 Unit Operational Problems

The following are categories of possible unit operational problems:

1. **Unit Does Not Power Up Correctly (see Section 3.1.1)**
2. **Unit Does Not Program/Operate Correctly (see Section 3.1.2)**
3. **Unit Does Not Perform Measurement Cycles Correctly (see Section 3.1.3)**
4. **Unit Does Not Display Data Correctly (see Section 3.1.4)**
5. **Unit Does Not Print Out Data Correctly (see Section 3.1.5)**
6. **Unit Can Not Be Programmed By Personal Computer (see Section 3.1.6)**

For any of the problem classifications listed above, the repair technician should locate the corresponding section for detailed problems. If the unit problem is not fully determined or associated with one of the above categories, perform the unit functional tests described in Chapter 7 to determine the unit problem.

3.1.1 Unit Does Not Power Up Correctly

The following is a comprehensive list of possible unit problems that may be found during unit power up:

1. **Unit Does Not Power Up, Nothing Displayed (see Section 4.1)**
2. **Unit Displays Unknown Messages Or Symbols (see Section 4.2)**
3. **Unit LCD Display Does Not Light Completely/Correctly (see Section 4.3)**
4. **Unit Displays "Autozeroing Failure" Message (see Section 4.4)**
5. **Unit Displays "Battery Failure" Message (see Section 4.5)**
6. **Unit Displays "Battery Warning" Message (see Section 4.6)**
7. **Unit Displays "RAM Failure" Message (see Section 4.7)**
8. **Unit Displays "ROM Failure" Message (see Section 4.8)**
9. **Unit Displays "Lithium Warning" Message (see Section 4.9)**
10. **Unit Displays "Clock Failure" Message (see Section 4.10)**
11. **Unit Displays "Defaults Changed" Message (see Section 4.11)**
12. **Unit Displays Incorrect Date/Time (see Section 4.12)**
13. **Unit Displays Incorrect Software Version (see Section 4.13)**
14. **Unit Displays "Valve Failure Code 01-15" (see Section 4.48)**

For any of the problems listed above, the repair technician should locate the corresponding section in Chapter 4 for a list of possible component failures for that specific unit problem. This list references diagnostic test procedures in Chapter 5 that will assist in determining possible component failures. If the unit problem occurs during power up but is not in one of the above categories, perform the unit functional tests described in Chapter 7 to determine the unit problem.

3.1.2 Unit Does Not Program/Operate Correctly

The following is a comprehensive list of possible unit problems that could be found during unit operation or programming:

1. **Unit LCD Display Does Not Light Completely/Correctly (see Section 4.3)**
2. **Unit Displays "Battery Failure" Message (see Section 4.5)**
3. **Unit Displays Incorrect Date/Time (see Section 4.12)**
4. **Display Goes Blank After Power Up Display (see Section 4.14)**
5. **Unit Does Not Respond To Button Presses (see Section 4.15)**
6. **Unit Does Not Display All Selections (see Section 4.16)**
7. **Unit Does Not Respond To Certain/Any Commands (see Section 4.17)**
8. **Unit Displays Only Date And Time (see Section 4.18)**
9. **Unit Uses Up Batteries Quickly (see Section 4.19)**
10. **Unit Displays "1 Day Max Limit" Message (see Section 4.20)**
11. **Unit Displays "300 RDG Limit" Message (see Section 4.21a)**
12. **Unit Restarts on Its Own (see Section 4.21b)**
13. **Unit Displays "Valve Failure Code 01-15" (see Section 4.48)**

For any of the problems listed above, the repair technician should locate the corresponding section in Chapter 4 for a list of possible component failures for that specific unit problem. This list references diagnostic test procedures in Chapter 5 that will assist in determining possible component failures. If the unit problem occurs during unit operation or unit programming but is not in one of the above categories, perform the unit functional tests described in Chapter 7 to determine the unit problem.

3.1.3 Unit Does Not Perform Measurement Cycles Correctly

The following is a comprehensive list of possible problems that could occur when the unit attempts to perform a measuring cycle:

1. **Unit Displays "Autozeroing Failure" Message When Starting Cycle (see Section 4.4)**
2. **Unit Displays "Battery Failure" Message When Starting Cycle (see Section 4.5)**
3. **Unit Will Not Perform Measurement Cycle (see Section 4.22)**
4. **Unit Displays "Printer/PC Cable Connected" When Starting Cycle (see Section 4.23)**
5. **Unit Displays Error Code 01 Displayed After Cycle (see Section 4.24)**
6. **Unit Displays Error Code 02 Displayed After Cycle (see Section 4.25)**
7. **Unit Displays Error Code 03 Displayed After Cycle (see Section 4.26)**
8. **Unit Displays Error Code 04 Displayed After Cycle (see Section 4.27)**
9. **Unit Displays Error Code 05 Displayed After Cycle (see Section 4.28)**
10. **Unit Displays Error Code 06 Displayed After Cycle (see Section 4.29)**
11. **Unit Displays Error Code 07 Displayed After Cycle (see Section 4.30)**
12. **Unit Displays Error Code 08 Displayed After Cycle (see Section 4.31)**
13. **Unit Displays Error Code 09 Displayed After Cycle (see Section 4.32)**
14. **Unit Displays Error Code 10 Displayed After Cycle (see Section 4.33)**
15. **Unit Displays Error Code 11 Displayed After Cycle (see Section 4.34)**
16. **Unit Displays Error Code 12 Displayed After Cycle (see Section 4.35)**
17. **Unit Displays Error Code 13 Displayed After Cycle (see Section 4.36)**

18. **Unit Performs Cycle But No Data Recorded/Data Lost (see Section 4.37)**
19. **Unit Performs Measurement Cycle But Data Incorrect (see Section 4.38)**
20. **Unit Displays "Valve Failure Code 01-15" (see Section 4.48)**

For any of the problems listed above, the repair technician should locate the corresponding section in Chapter 4 for a list of possible component failures for that specific unit problem. This list references diagnostic test procedures in Chapter 5 that will assist in determining possible component failures. If the unit problem occurs during the unit measuring cycle or is a result of the unit measuring cycle, perform the unit functional tests described in Chapter 7 to determine the unit problem.

3.1.4 Unit Does Not Display Data Correctly

The following is a comprehensive list of possible problems when attempting to display unit data:

1. **Unit Does Not Display "Display Data" Command (see Section 4.39)**
2. **Unit Does Not Respond To "Display Data" Command (see Section 4.40)**
3. **Data Displayed By Unit Is Incorrect/Lost Data (see Section 4.41)**

For any of the problems listed above, the repair technician should locate the corresponding section in Chapter 4 for a list of possible component failures for that specific unit problem. This list references diagnostic test procedures in Chapter 5 that will assist in determining possible component failures. If the unit problem occurs when trying to display data on the unit LCD but is not in one of the above categories, perform the unit functional tests described in Chapter 7 to determine the unit problem.

3.1.5 Unit Does Not Print Out Data Correctly

The following is a comprehensive list of possible problems when attempting to print unit data to an externally connected printer:

1. **Unit Does Not Display "Print Data" Command (see Section 4.42)**
2. **Unit Does Not Respond To "Print Data" Command (see Section 4.43)**
3. **Unit Shows Data Being Printed But Printer Does Not Operate (see Section 4.44)**
4. **Data Printed Out By Unit Is Incorrect (see Section 4.45)**

For any of the problems listed above, the repair technician should locate the corresponding section in Chapter 4 for a list of possible component failures for that specific unit problem. This list references diagnostic test procedures in Chapter 5 that will assist in determining possible component failures. If the unit problem occurs when attempting to print data but is not in one of the above categories, perform the unit functional tests described in Chapter 7 to determine the unit problem.

3.1.6 Unit Can Not Be Programmed By Personal Computer

The following is a comprehensive list of possible unit problems that could occur while attempting to program the unit with the PC Diskette Software (Part #5100-61 for English model, Part #'s 5100-62 through 5100-65 for foreign language models):

1. **PC Software Displays Unit Communication Error (see Section 4.46)**
2. **Unit Parameters/Data Is Inconsistent With PC Software Display (see Section 4.47)**

For any of the problems listed above, the repair technician should locate the corresponding section in Chapter 4 for a list of possible component failures for that specific unit problem. This list references diagnostic test procedures in Chapter 5 that will assist in determining possible component failures. If the unit problem occurs during unit PC programming but is not in one of the above categories, perform the unit functional tests described in Chapter 7 to determine the unit problem.

3.2 Unit Has Been Physically Damaged Or Discolored

The following is a comprehensive list of possible externally visible components (those that can be seen by the user) that can be damaged or discolored:

1. **Microphone is Rusty (see Section 6.13)**
2. **Microphone plug is stuck (see Section 6.13)**
3. **LCD/LCD Window Is Damaged/Discolored (See Section 6.4)**
4. **Front/Rear Housing Or Battery Door Is Damaged/Discolored (see Section 6.12)**
5. **Pneumatic Interface/Microphone Is Damaged/Discolored (see Section 6.13)**
6. **Arm Cuff or Bladder Is Damaged/Discolored (see Section 6.13)**
7. **Monitor Pouch, Belt Strap, Shoulder Strap, Or Cuff Anchoring Strap Is Damaged Discolored (see Section 6.13)**
8. **Printer Or PC Cable Is Damaged/Discolored (see Section 6.13)**
9. **Battery Door Plate is Loose or Missing (see Section 6.12)**
10. **Battery Housing or Springs Corroded (see Section 6.12)**

For any of the damaged components listed above, repair is simply component/system replacement. See the corresponding section numbers listed above for specific replacement procedure for damaged/discolored component. If the unit component that is damaged/discolored is an externally visible component but not located in the above list, contact Tycos Instruments for specific repair/replacement procedure. For internally damaged/discolored components found during unit diagnostic tests, refer to Chapter 6 for specific repair/ action replacement for that component.

CHAPTER 4:

Guide To Possible Unit Component Failures

Chapter 4: Guide To Possible Unit Component Failures

Listed below are the possible unit operational problems provided in Chapter 3.

1. **Unit Does Not Power Up, Nothing Displayed (see Section 4.1)**
2. **Unit Displays Unknown Message Or Symbols (see Section 4.2)**
3. **Unit LCD Display Does Not Light Completely/Correctly (see Section 4.3)**
4. **Unit Displays "Autozeroing Failure" Message (see Section 4.4)**
5. **Unit Displays "Battery Failure" Message (see Section 4.5)**
6. **Unit Displays "Battery Warning" Message (see Section 4.6)**
7. **Unit Displays "RAM Failure" Message (see Section 4.7)**
8. **Unit Displays "ROM Failure" Message (see Section 4.8)**
9. **Unit Displays "Lithium Warning" Message (see Section 4.9)**
10. **Unit Displays "Clock Failure" Message (see Section 4.10)**
11. **Unit Displays "Defaults Changed" Message (see Section 4.11)**
12. **Unit Displays Incorrect Date/Time (see Section 4.12)**
13. **Unit Displays Incorrect Software Version (see Section 4.13)**
14. **Display Goes Blank After Power Up Display (see Section 4.14)**
15. **Unit Does Not Respond To Button Presses (see Section 4.15)**
16. **Unit Does Not Respond To Certain/Any Commands (see Section 4.16)**
17. **Unit Does Not Display All Selections (see Section 4.17)**
18. **Unit Displays Only Date And Time (see Section 4.18)**
19. **Unit Uses Up Batteries Quickly (see Section 4.19)**
20. **Unit Displays "1 Day Max Limit" Message (see Section 4.20)**

21a. **Unit Displays "300 RDG Limit" Message (see Section 4.21a)**

21b. **Unit Restarts on Its Own (see Section 4.21b)**

22. **Unit Will Not Perform Measurement Cycle (see Section 4.22)**
23. **Unit Displays "Printer/PC Cable Connected" Message (see Section 4.23)**
24. **Unit Displays Error Code 01 Displayed After Cycle (see Section 4.24)**
25. **Unit Displays Error Code 02 Displayed After Cycle (see Section 4.25)**
26. **Unit Displays Error Code 03 Displayed After Cycle (see Section 4.26)**
27. **Unit Displays Error Code 04 Displayed After Cycle (see Section 4.27)**
28. **Unit Displays Error Code 05 Displayed After Cycle (see Section 4.28)**
29. **Unit Displays Error Code 06 Displayed After Cycle (see Section 4.29)**
30. **Unit Displays Error Code 07 Displayed After Cycle (see Section 4.30)**
31. **Unit Displays Error Code 08 Displayed After Cycle (see Section 4.31)**
32. **Unit Displays Error Code 09 Displayed After Cycle (see Section 4.32)**
33. **Unit Displays Error Code 10 Displayed After Cycle (see Section 4.33)**
34. **Unit Displays Error Code 11 Displayed After Cycle (see Section 4.34)**
35. **Unit Displays Error Code 12 Displayed After Cycle (see Section 4.35)**
36. **Unit Displays Error Code 13 Displayed After Cycle (see Section 4.36)**
37. **Unit Performs Cycle But No Data Recorded/Data Lost (see Section 4.37)**
38. **Unit Performs Measurement Cycle But Data Incorrect (see Section 4.38)**
39. **Unit Does Not Display "Display Data" Command (see Section 4.39)**
40. **Unit Does Not Respond To "Display Data" Command (see Section 4.40)**
41. **Data Displayed By Unit Is Incorrect/Lost Data (see Section 4.41)**
42. **Unit Does Not Display "Print Data" Command (see Section 4.42)**

43. **Unit Does Not Respond To "Print Data" Command (see Section 4.43)**
44. **Unit Shows Data Being Printed But Printer Does Not Operate (see Section 4.44)**
45. **Data Printed Out By Unit Is Incorrect (see Section 4.45)**
46. **PC Software Displays Unit Communication Error (see Section 4.46)**
47. **Unit Parameters/Data Is Inconsistent With PC Software Display (see Section 4.47)**
48. **Unit Displays "Valve Failure Code 01-15" (see Section 4.48)**

There is a corresponding section in this chapter for each problem listed on the previous page. The repair technician should reference the section corresponding to the diagnosed unit problem to see which unit components may not be operating properly. Refer to Chapter 5's unit problem guide to determine which, if any, unit problems apply to the failed unit.

4.1 Unit Does Not Power Up, Nothing Displayed

The following are the possible component failures if the unit will not power up, i.e. nothing happens and/or nothing is displayed when power is applied to the unit (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit in Auto Mode, Batteries Inserted Wrong
2. **Main Battery Pack Failure (see Section 5.8)**
   -Weak Batteries, Batteries too small, Battery door loose
3. **LCD Failure (see Section 5.5)**
   - LCD disconnected, LCD module failed
4. **Power Supply PCB Failure (see Section 5.2)**
5. **Main PCB Failure (see Section 5.1)**
   -Lithium battery leg shorted to trace

4.2 Unit Displays Unknown Messages Or Symbols

The following are the possible component failures if the unit display is incorrect, i.e. the displays shows unknown messages or symbols (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
2. **LCD Failure (see Section 5.5)**
   -LCD partially disconnected
3. **Lithium Battery Failure (see Section 5.9)**
4. **Power Supply PCB Failure (see Section 5.2)**
5. **Main PCB Failure (see Section 5.1)**

4.3 Unit LCD Display Does Not Light Completely/Correctly

The following are the possible component failures if the unit LCD does not light completely or correctly, i.e. half of display does not work, elements in display characters not illuminated, etc. (failures are listed in the order in which they should be checked):

1. **LCD Failure (see Section 5.5)**
   -LCD disconnected, LCD module failed
2. **Power Supply PCB Failure (see Section 5.2)**
3. **Main PCB Failure (see Section 5.1)**

4.4 Unit Displays "Autozeroing Failure" Message

The following are the possible component failures if the unit displays the "Autozero Failure" message (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Patient arm movement, cuff remains inflated
2. **External Pneumatics Failure (see Section 5.12)**
   -Tubing blocked, kinked
3. **Internal pneumatics Failure (see Section 5.13)**
   -Tubing blocked, kinked
4. **Pressure sensor Failure (see Section 5.3)**
5. **Power Supply PCB Failure (see Section 5.2)**
6. **Main PCB Failure (see Section 5.1)**
   -Pressure transducer calibration, pressure transducer failed, circuitry

4.5 Unit Displays "Battery Failure" Message

The following are the possible component failures if the unit displays "Battery Failure" message (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Rechargeable batteries, Batteries not installed OK
2. **Main Battery Pack Failure (see Section 5.8)**
   -Weak batteries
3. **Power Supply PCB Failure (see Section 5.2)**
4. **Main PCB Failure (see Section 5.1)**
   -Improper Voltage Reading

4.6 Unit Displays "Battery Warning" Message

The following are the possible component failures if the unit displays "Battery Warning" message (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Rechargeable batteries, Batteries not installed OK
2. **Main Battery Pack Failure (see Section 5.8)**
   -Weak batteries
3. **Power Supply PCB Failure (see Section 5.2)**
4. **Main PCB Failure (see Section 5.1)**
   -Improper voltage reading

4.7 Unit Displays "RAM Failure" Message

The following are the possible component failures if the unit displays "RAM Failure" message (failures are listed in the order in which they should be checked):

1. **Lithium Battery Failure (see Section 5.9)**
   -Lithium battery weak, lithium battery disconnected/unsoldered
2. **Main PCB Failure (see Section 5.1)**

4.8 Unit Displays "ROM Failure" Message

The following are the possible component failures if the unit displays "ROM Failure" message (failures are listed in the order in which they should be checked):

1. **Main PCB Failure (see Section 5.1)**

4.9 Unit Displays "Lithium Warning" Message

The following are the possible component failures if the unit displays the "Lithium Warning" message (failures are listed in the order in which they should be checked):

1. **Main PCB Failure (see Section 5.1)**

4.10 Unit Displays "Clock Failure" Message

The following are the possible component failures if the unit displays "Defaults Changed" message (failures are listed in the order in which they should be checked):

1. **Lithium Battery Failure (see Section 5.9)**
   -Lithium battery too weak, Lithium battery disconnected/unsoldered
2. **Main PCB Failure (see Section 5.1)**

4.11 Unit Displays "Defaults Changed" Message

The following are the possible component failures if the unit displays "Defaults Changed" message (failures are listed in the order in which they should be checked):

1. **Control Software Failure (see Section 5.15)**
2. **Lithium Battery Failure (see Section 5.9)**
   -Lithium battery too weak, Lithium battery disconnected/unsoldered
3. **Main PCB Failure (see Section 5.1)**

4.12 Unit Displays Incorrect Date/Time

The following are the possible component failures if the unit time or date is incorrect (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
2. **Lithium Battery Failure (see Section 5.9)**
   -Lithium battery too weak, Lithium battery disconnected/unsoldered
3. **Main PCB Failure (see Section 5.1)**

4.13 Unit Displays Incorrect Software Version

The following are the possible component failures if the unit displays an incorrect software version (failures are listed in the order in which they should be checked):

1. **Control Software Failure (see Section 5.15)**

4.14 Unit Display Goes Blank After Power Up Display

The following are the possible component failures if the unit display goes blank after completing display of power up messages (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
2. **LCD Failure (see Section 5.5)**
3. **Power Supply PCB Failure (see Section 5.2)**
   -Loose batteries, loose battery door plate, Battery Springs Disconnected
4. **Main PCB Failure (see Section 5.1)**
   -Flex cable disconnected, Lithium battery shorting to board

4.15 Unit Does Not Respond To Button Presses

The following list contains the possible component failures if the unit does displays commands but does not respond to button presses (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
2. **Keypad Failure (see Section 5.6)**
   -Dirty keypad contacts
3. **Power Supply PCB Failure (see Section 5.2)**
   -Flex circuit disconnected
4. **Main PCB Failure (see Section 5.1)**

4.16 Unit Does Not Respond To Certain/Any Commands

The following list contains the possible component failures if the unit will not respond to input for certain or any commands (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit in run mode
2. **Keypad Failure (see Section 5.6)**
3. **Power Supply PCB Failure (see Section 5.2)**
4. **Main PCB Failure (see Section 5.1)**

4.17 Unit Does Not Display All Selections

The following list contains the possible component failures if unit menu does display some but not all possible commands listed in ABPM Operator Manual (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit in run mode, No data in Unit, etc.
2. **Control Software Failure (see Section 5.15)**
3. **Main PCB Failure (see Section 5.1)**

4.18 Unit Displays Only Date and Time

The following list contains the possible component failures if the unit only displays the date and time (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit in run mode
2. **Main PCB Failure (see Section 5.1)**

4.19 Unit Uses Up Batteries Quickly

The following list contains the possible component failures if the unit consistently expends batteries faster than anticipated according to ABPM Operator's Manual (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Rechargeable batteries
2. **Keypad Failure (see Section 5.6)**
3. **Power Supply PCB Failure (see Section 5.2)**
4. **Main PCB Failure (see Section 5.1)**
   -Unit not going to sleep,
5. **Serial receptacle (see Section 5.7.1)**

4.20 Unit Displays "1 Day Max Limit" Message

The following list contains the possible component failures if the unit displays "1 Day Max Limit" message; this is intended to indicate that a reading has been attempted after the programmed 24 hour period has elapsed and the unit is set for 1 day maximum limit (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit programmed wrong

4.21a Unit Displays "300 RDG Limit" Message

The following list contains the possible component failures if the unit displays "300 RDG Limit" message; this is intended to indicate that 300 or more readings have been attempted with the unit and that its memory can not store any more data (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit programmed wrong

4.21b Unit Restarts on Its Own

The following list contains the possible component failures if the unit restarts on its own during power up (failures are listed in the order in which they should be checked):

1. **Main Battery Pack (see Section 5.8)**
   -Battery springs not soldered completely, battery door loose
2. **Power Supply PCB Failure (see Section 5.2)**
   -Flex circuit disconnected, PCB failed
3. **Main PCB Failure (see Section 5.1)**
   -Lithium battery touching electrical trace, PCB failed

4.22 Unit Will Not Perform Measurement Cycle

The following list contains the possible component failures if the unit will not perform a measurement cycle although it responds to the command "Start Office Cycle" (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Pneumatic assembly not connected, pump disconnected
2. **Main Battery Pack (see Section 5.8)**
   -Batteries too weak
3. **Power Supply PCB Failure (see Section 5.2)**
4. **Main PCB Failure (see Section 5.1)**

4.23 Unit Displays "Printer/PC Cable Connected" Message

The following list contains the possible component failures if the unit displays "Printer Connected" message when the "Start Office Cycle" command is issued (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Printer or PC cable plugged into unit
2. **Unit Serial Port Receptacle (see Section 5.7)**
   -Serial receptacle shorted
3. **Main PCB Failure (see Section 5.1)**

4.24 Unit Displays Error Code 01 After Cycle

The following list contains the possible component failures if the unit displays the error code 01 after completing a measuring cycle (single or regular run mode) which indicates that the cycle was stopped prematurely (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Weak batteries, buttons pressed during cycle
2. **Power Supply PCB Failure (see Section 5.2)**
   -Keypad contacts dirty, flex circuit disconnected
3. **Main PCB Failure (see Section 5.1)**
   -Flex circuit disconnected, PCB failure

4.25 Unit Displays Error Code 02 After Cycle

The following list contains the possible component failures if the unit displays the error code 02 after completing a measuring cycle (single or regular run mode) which indicates that the unit detected a major air leak while inflating the cuff (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Large arm/large cuff combination
2. **External Pneumatics Failure (see Section 5.14)**
   -Cuff leaks, Luer lock not connected tightly
3. **Internal Pneumatics Failure (see Section 5.13)**
   -Manifold leak, valve leaks, pump leaks, loose tubing
4. **Pressure sensor Failure (see Section 5.3)**
5. **Power Supply PCB Failure (see Section 5.2)**
6. **Main PCB Failure (see Section 5.1)**

4.26 Unit Displays Error Code 03 After Cycle

The following list contains the possible component failures if the unit displays the error code 03 after completing a measuring cycle which indicates that the power being supplied to the unit was too low to complete the cycle (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   - Rechargeable batteries, weak batteries
2. **Main Battery Pack Failure (see Section 5.8)**
3. **Power Supply PCB Failure (see Section 5.2)**
4. **Main PCB Failure (see Section 5.1)**

4.27 Unit Displays Error Code 04 After Cycle

The following list contains the possible component failures if the unit displays the error code 04 after completing a measuring cycle (single or regular run mode) which indicates an autozero failure during the cycle (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Excessive arm movement, cuff squeezed
2. **External Pneumatics Failure (see Section 5.14)**
   -External pressure being applied, kinked hose
3. **Internal Pneumatics Failure (see Section 5.13)**
   -Kinked or pinched tubing
4. **Pressure sensor Failure (see Section 5.3)**
5. **Power Supply PCB Failure (see Section 5.2)**
6. **Main PCB Failure (see Section 5.1)**

4.28 Unit Displays Error Code 05 After Cycle

The following list contains the possible component failures if the unit displays the error code 05 after completing a measuring cycle (single or regular run mode) which indicates that the target pressure was reached too quickly (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Kinked hose
2. **External Pneumatics Failure (see Section 5.14)**
   -Blocked hose
3. **Internal Pneumatics Failure (see Section 5.13)**
   -Pinched tubing
4. **Pressure sensor Failure (see Section 5.3)**
   5. Power Supply PCB Failure (see Section 5.2)
6. **Main PCB Failure (see Section 5.1)**

4.29 Unit Displays Error Code 06 After Cycle

The following list contains the possible component failures if the unit displays the error code 06 after completing a measuring cycle (single or regular run mode) which indicates that the unit over pressurized during cycle (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Excessive arm movement, cuff squeezed
2. **External Pneumatics Failure (see Section 5.14)**
   -Kinked tubing
3. **Internal Pneumatics Failure (see Section 5.13)**
   -Pinched tubing
4. **Pressure sensor Failure (see Section 5.3)**
   5. Power Supply PCB Failure (see Section 5.2)
6. **Main PCB Failure (see Section 5.1)**

4.30 Unit Displays Error Code 07 After Cycle

The following list contains the possible component failures if the unit displays the error code 07 after completing a measuring cycle (single or regular run mode) which indicates that the unit was held at a pressure over 10 mmHg for more than 240 seconds (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Old ABPM software and hardware versions
2. **Internal Pneumatics Failure (see Section 5.13)**
   -Pinched tubing
3. **Pressure sensor Failure (see Section 5.3)**
4. **Power Supply PCB Failure (see Section 5.2)**
5. **Main PCB Failure (see Section 5.1)**

4.31 Unit Displays Error Code 08 After Cycle

The following list contains the possible component failures if the unit displays the error code 08 (which indicates that the unit detected too much Korotkoff sounds artifact during the cycle) after completing a measuring cycle (single or regular run mode). Failures are listed in the order in which they should be checked:

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit previously used on weak signal person, poor microphone placement
2. **Microphone Failure (see Section 5.12)**
3. **Internal Microphone Circuitry Failure (see Section 5.4)**
   -Microphone receptacle shorted, disconnected
4. **Main PCB Failure (see Section 5.1)**

4.32 Unit Displays Error Code 09 After Cycle

The following list contains the possible component failures if the unit displays the error code 9 after completing a measuring cycle (single or regular run mode) which indicates that the unit did not detect any Korotkoff sounds during the cycle (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit used on weak signal person, poor microphone placement
2. **Microphone Failure (see Section 5.12)**
3. **Internal Microphone Circuitry Failure (see Section 5.4)**
   -Microphone receptacle shorted, disconnected
4. **Main PCB Failure (see Section 5.1)**

4.33 Unit Displays Error Code 10 After Cycle

The following list contains the possible component failures if the unit displays the error code 10 after completing a measuring cycle (single or regular run mode) which indicates that the Korotkoff sounds detected by the unit during the cycle were too weak (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit used on weak signal person, poor microphone placement
2. **Microphone Failure (see Section 5.12)**
3. **Internal Microphone Circuitry Failure (see Section 5.4)**
   -Microphone receptacle shorted, disconnected
4. **Main PCB Failure (see Section 5.1)**

4.34 Unit Displays Error Code 11 After Cycle

The following list contains the possible component failures if the unit displays the error code 11 after completing a measuring cycle (single or regular run mode) which indicates that the Korotkoff sounds detected by the unit during the cycle were too strong (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit used on weak signal person, poor microphone placement
2. **Microphone Failure (see Section 5.12)**
3. **Internal Microphone Circuitry Failure (see Section 5.4)**
   -Microphone receptacle shorted, disconnected
4. **Main PCB Failure (see Section 5.1)**

4.35 Unit Displays Error Code 12 After Cycle

The following list contains the possible component failures if the unit displays the error code 12 after completing a measuring cycle (single or regular run mode) which indicates that the blood pressure determined by the unit from the Korotkoff sounds measured during the cycle was out of the programmed range of measurement (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit used on weak signal person, poor microphone placement
2. **Microphone Failure (see Section 5.12)**
3. **Internal Microphone Circuitry Failure (see Section 5.4)**
   -Microphone receptacle shorted, disconnected
4. **Main PCB Failure (see Section 5.1)**

4.36 Unit Displays Error Code 13 After Cycle

The following list contains the possible component failures if the unit displays the error code 13 after completing a measuring cycle (single or regular run mode) which indicates that the detected Korotkoff sounds were above target systolic pressure during the measuring cycle (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit used on weak signal person, poor microphone placement
2. **Microphone Failure (see Section 5.12)**
3. **Internal Microphone Circuitry Failure (see Section 5.4)**
   -Microphone receptacle shorted, disconnected
4. **Main PCB Failure (see Section 5.1)**

4.37 Unit Performs Cycle But No Data Recorded/Lost Data

The following list contains the possible component failures if the unit performs a measuring cycle (single or regular run mode) but indicates that no data was stored (failures are listed in the order in which they should be checked):

1. **Main PCB Failure (see Section 5.1)**
   -Lithium battery weak, lithium battery not soldered to PCB

4.38 Unit Performs Measurement Cycle But Data Incorrect

The following list contains the possible component failures if the unit performs a measuring cycle (single or regular run mode) but the data recorded was found to be incorrect when the patient's blood pressure is checked with another method, i.e. standard sphygmopressure sensor (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Unit used on weak signal person, poor microphone placement
2. **Pressure sensor Failure (see Section 5.3)**
3. **External Pneumatics Failure (see Section 5.14)**
4. **Internal Pneumatics Failure (see Section 5.13)**
5. **Microphone Failure (see Section 5.12)**
6. **Internal Microphone Circuitry Failure (see Section 5.4)**
7. **Main PCB Failure (see Section 5.1)**

4.39 Unit Does Not Display "Display Data" Command

The following list contains the possible component failures if the unit does not display "Display Data" command after at least one measuring cycle (single or regular run mode) has been completed (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -No data stored
2. **Main PCB Failure (see Section 5.1)**

4.40 Unit Does Not Respond To "Display Data" Command

The following list contains the possible component failures if the unit displays the "Display Data" command but does not respond to it when the unit buttons are pressed (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
2. **Keypad Failure (see Section 5.6)**
3. **Power Supply PCB Failure (see Section 5.2)**
4. **Main PCB Failure (see Section 5.1)**

4.41 Data Displayed By Unit Is Incorrect/Lost Data

The following list contains the possible component failures if the data displayed by the unit is incorrect, i.e. the data is garbled or the data is not the data that was shown during the unit measuring cycles (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
2. **Main PCB Failure (see Section 5.1)**
   -Lithium battery weak, lithium battery not soldered to PCB

4.42 Unit Does Not Display "Print Data" Command

The following list contains the possible component failures if the unit does not display the "Print Data" command after completing at least one measuring cycle (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -No data stored
2. **Main PCB Failure (see Section 5.1)**

4.43 Unit Does Not Respond To "Print Data" Command

The following list contains the possible component failures if the unit displays the "Print Data" command but does not respond to any key presses while it is displayed (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
2. **Keypad Failure (see Section 5.6)**
3. **Main PCB Failure (see Section 5.1)**

4.44 Unit Shows Data Being Printed But Printer Does Not Operate

The following list contains the possible component failures if the unit displays "Printing Data" message but no data is printed by the connected printer (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Wrong cable, wrong printer, printer not setup properly
2. **Printer Serial Cable Failure (see Section 5.10)**
3. **Unit Serial Port Receptacle Failure (see Section 5.7)**
4. **Main PCB Failure (see Section 5.1)**

4.45 Data Printed Out By Unit Is Incorrect

The following list contains the possible component failures if the data printed out by the unit is garbled or does not match the data displayed on the unit (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Wrong cable, wrong printer, printer not setup properly
2. **Printer Serial Cable Failure (see Section 5.10)**
3. **Unit Serial Port Receptacle Failure (see Section 5.7)**
4. **Main PCB Failure (see Section 5.1)**

4.46 PC Software Displays Unit Communication Error

The following list contains the possible component failures if the ABPM PC Diskette Software displays a communication error with unit (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Wrong cable, wrong PC port, PC not setup properly
2. **PC Serial Cable Failure (see Section 5.11)**
3. **Unit Serial Port Receptacle Failure (see Section 5.7)**
4. **Main PCB Failure (see Section 5.1)**

4.47 Unit Parameters/Display Is Inconsistent With PC Software Display

The following list contains the possible component failures if the unit programming parameters or data in the unit are different from the parameters written to the unit; or the data read from the unit by the ABPM PC Diskette Software is different from that stored in the unit (failures are listed in the order in which they should be checked):

1. **Improper Operation/Programming (see Section 5.16)**
   -Wrong cable, wrong PC port, PC not setup properly
2. **PC Serial Cable Failure (see Section 5.11)**
3. **Unit Serial Port Receptacle Failure (see Section 5.7)**
4. **Main PCB Failure (see Section 5.1)**

4.48 Unit Displays "Valve Failure Code 01-15"

The following list contains the definition of the valve failure code and the component that failed.

1. **01 - Dump Valve Fail Open (see Section 5.18)**
2. **02 - Dump Valve Fail Closed (see Section 5.18)**
3. **03 - Dump Valve Fail Open and Closed (see Section 5.18)**
4. **04 - Dump Valve Stuck (see Section 5.18)**
5. **05 - Dump Valve Stuck Open (see Section 5.18)**
6. **06 - Dump Valve Stuck Closed (see Section 5.18)**
7. **07 - Dump Valve Stuck, Fail Open and Closed (see Section 5.18)**
8. **08 - Control Valve Fail Home (see Section 5.17)**
9. **09 - Control Valve Fail Home and Dump Valve Fail Open (see Section 5.17 & 18)**
10. **10 - Control Valve Fail Home and Dump Valve Fail Closed (see Section 5.17 & 18)**
11. **11 - Control Valve Fail Home and Dump Valve Fail Open and Closed (see Section 5.17 & 18)**
12. **12 - Control Valve Fail Home and Dump Valve Stuck (see Section 5.17 & 18)**
13. **13 - Control Valve Fail Home and Dump Valve Stuck Open (see Section 5.17 & 18)**
14. **14 - Control Valve Fail Home and Dump Valve Stuck Closed (see Section 5.17 & 18)**
15. **15 - Control Valve Fail Home and Dump Valve Stuck, Fail Open and Closed (see Section 5.17 & 18)**

CHAPTER 5:

Unit Diagnostic Test Procedures

Chapter 5: Diagnostic Test Procedures

This chapter contains the following diagnostic test procedures needed to determine proper operation of unit components:

(Electrical/Electronic Component Diagnostic Tests)

1. **Main PCB (see Section 5.1)**
2. **Power Supply PCB (see Section 5.2)**
3. **Pressure sensor (see Section 5.3)**
4. **Internal Microphone Circuitry (see Section 5.4)**
5. **LCD (see Section 5.5)**
6. **Keypad (see Section 5.6)**
7. **Unit Serial Port Receptacle (see Section 5.7)**
8. **Main Battery Pack (see Section 5.8)**
9. **Lithium Battery (see Section 5.9)**
10. **Printer Serial Cable (see Section 5.10)**
11. **PC Serial Cable (see Section 5.11)**
12. **Microphone (see Section 5.12)**

(Pneumatic Component Diagnostic Tests)

13. **Internal Pneumatics (see Section 5.13)**
14. **External Pneumatics (see Section 5.14)**

(Miscellaneous Component Diagnostic Tests)

15. **Control Software (see Section 5.15)**
16. **Improper Operation/Programming (see Section 5.16)**
17. **Control Valve (see Section 5.17)**
18. **Dump Valve (see Section 5.18)**

Some of the unit diagnostic test procedures in this chapter have acceptance limits or criteria intended to detect any bad components or circuit connections. These values are to be used for diagnostic purposes only and do not replace or waive any of the product specifications in Document 126P171.

This chapter's diagnostic procedures utilize the unit's control software. Refer to Appendices 9.4 for more information on the unit control software. Several of the diagnostic procedures involve checking for proper voltages or signals on the main PCB or power supply PCB. Use the main PCB's circuit schematic and assembly drawings (ABPM Assembly Drawings 109P375 and 125S205) and the power supply PCB's circuit schematic and assembly drawings (ABPM Assembly Drawings 109P376 and 125S206) for location references and use the specified oscilloscope or multimeter (with needle probe) for the test procedures.

The following diagnostic tests should be performed on a grounded bench mat and the repair personnel should use a personal grounding strap. The test equipment listed in Chapter 2 is required to perform the diagnostic test procedures in addition to some of the repair tools which will be required for unit disassembly and assembly.

All information gathered during unit diagnostic testing must be recorded on a unit data sheet (see Appendix 9.1) and be maintained in the service center's records.

(Electrical/Electronic Component Diagnostic Tests)

5.1 Main PCB

The main PCB board contains the unit's microprocessor, serial port controller, real time clock (RTC), watch dog timer (WDT), random access memory (RAM), read only memory (ROM), analog to digital (A/D) converter, microphone amplifier circuitry, pressure sensor, pressure sensor amplifier circuitry, dynamic pressure circuitry, power down circuitry, over 10 mmHg fail-safe latch, pump operation fail-safe latch, over pressure detection circuitry, the +2 VDC voltage reference, the +4 VDC voltage references, the dump valve circuitry, and the lithium battery backup circuitry.

NOTE: BEFORE PERFORMING ANY MAIN PCB DIAGNOSTICS, CHECK THAT ALL THE UNIT INTERNAL COMPONENTS ARE CONNECTED PROPERLY.

If the unit's microprocessor, WDT, RAM, or ROM fail, the unit usually will not be able to complete the unit power on self test (POST). Other improper operations can result from these components that will not be detected during the POST, but there are no direct diagnostic routines to check for these failures. The Real Time Clock (RTC) can be checked by seeing that the unit goes to "sleep" (reduces current) and then wakes up for 1 second every minute.

If the A/D converter fails, the unit will not read signals correctly from the unit's microphone, pressure sensor, or batteries. This can result in improper unit measurements or improper operations associated with the unit batteries. Perform the diagnostic test in Section 5.1.1 to check the A/D converter.

If the serial port controller fails, the unit will not be able to communicate information correctly with an external PC or printer. If the diagnostic tests in Sections 5.7, 5.10 and 5.11 are negative but the unit still will not communicate properly, then replace the main PCB.

If the microphone amplifier circuitry fails, the unit will not perform the measurement cycles correctly. Perform the diagnostic routines in section 5.4 and 5.12 and check the external microphone components first. If the external components are OK but the unit still has microphone problems replace the main PCB.

If the pressure sensor or pressure sensor amplifier circuitry fails, the unit will not perform the measurement cycles correctly or may not autozero. Perform the diagnostic routines in section 5.3 to check proper pressure sensor operation. If the pressure sensor does not work correctly, replace the main PCB or the pressure sensor. Otherwise, continue to check the other associated pneumatics for failures.

If the dynamic amplifier circuitry fails, the unit will not perform the measurement cycles correctly. There are no direct diagnostic routines to check this circuitry. If the unit's pressure sensor and pneumatics operate OK but the unit still does not measure properly, that may indicate dynamic pressure circuitry failure. Fix this by replacing the main PCB.

If the Over 10 mmHg Fail-safe latch, Pump Operation Fail-safe latch, or the Over Pressure detection circuitry fail, the unit pump or valve will not operate properly and this will prevent proper user operation. The Over 10 mmHg Fail-safe and Pump Operation latches may not operate properly if the hardware and software versions for the unit have not been properly updated (see Chapter 8). The Over Pressure detection may not operate correctly if the unit pressure sensor is out of calibration. If all other unit components are operating properly, these fail-safe circuits can be tested through the corresponding functional tests in Chapter 7. Replace main PCB if determined as failure.

If the +2 VDC voltage reference or the +4 VDC voltage reference fail, the unit's amplifier and A/D circuits will not operate properly. Perform the diagnostic test in Section 5.1.2 to check these references.

If the dump valve or its circuitry fails, the unit valve will not operate properly. Check this circuit with the valve operation diagnostic routines in Section 5.18.

If the lithium battery backup circuitry or the power down circuitry fail, the unit will not operate correctly. A lithium battery failure will cause the unit to lose data and not maintain time settings properly. There are no direct diagnostic procedures to check these circuits, so if the unit's main battery pack and power supply PCB are OK (use procedures in Sections 5.2 and 5.8), the main PCB needs to be replaced (use procedure in Section 6.1).

If the unit continues to malfunction and the appropriate components have checked for proper operation, perform the test of the main PCB using the diagnostic routine in Section 5.1.3. If the main PCB is faulty, replace using the procedure in Section 6.1.

5.1.1 A/D Converter Diagnostics

The A/D is tested using the "10 Bit A/D Test" in the unit's "Detailed Tests" menu (see Appendix 9.4). Each channel can be displayed along with its converted value.

Each channel should have readings in the range shown on the chart below. The unit battery voltage should be 6 VDC, unit microphone should be disconnected, and external pneumatics should be disconnected.

CH0	Gauge Pressure	0011 - 0015
CH1	Ksnds	0480 - 0540 (Max Gain)
CH2	2nd Microphone	Undefined Values
CH3	Dynamic Pressure	Undefined Values
CH4	Auxiliary	Undefined Values
CH5	+BAT	610 - 1030
CH6	-BAT	600 - 790
CH7	+12V Connection	0 - 0004 (with zero volts between breakout terminals 3 and 5)
		0815 - 0855 (with +12 VDC between breakout terminals 3 and 5)

If the A/D signals are incorrect replace the main PCB following the procedure in Section 6.1.

5.1.2 + 2 VDC, + 4 VDC Voltage References Diagnostics

Open the unit following Steps 1 and 2 of the unit disassembly procedure (Appendix 9.2). Check the +4 VA voltage at the J21 pin of the main PCB. The voltage should be 4.000 VDC +/- 0.010 . Adjust the adjustment pot for a 4.000 VDC reading if it is not. Check the +2 VA reference from pin 10 of J40. Acceptable limits are 1.990V to 2.010V. Measure the peak to peak noise on both references with an oscilloscope. The noise should be minimal should be less than 2 milliVolts peak to peak.

If the +2 and +4 VDC references can not adjusted into range, replace the main PCB following the procedure in Section 6.1.

5.1.3 Main PCB Diagnostics

If the main PCB is believed to have failed, remove the PCB following Steps 1 through 11 of the unit disassembly procedure (see Appendix 9.2). Replace the main PCB with a known good main PCB and then reassemble the unit following Steps 22 through 26 of the unit reassembly procedure (see Appendix 9.3). If the unit functions properly afterwards, then the main PCB was the cause and the replacement should be made permanent (see Section 6.1). If the unit continues to malfunction, check that all the flex circuits and components are connected properly and retest. If failure continues, return the unit to Tycos Instruments with a complete written explanation of failure.

5.2 Power Supply PCB

The power supply converts the power supplied by the main battery pack to a positive (+) 5 VDC digital supply voltage which is in turn converted into positive (+) 5 VDC analog power supply and (-) 5 VDC analog power supply voltage supply. The power supply PCB also contains the pressure-sensitive switches which interface to the keypad, the motor drive circuitry that powers the unit's pump during inflation, and the flex circuit that connects it to the main PCB.

If the flex circuit is not connected properly or has been damaged, the unit will not work properly. Check this first following the procedure in Section 5.2.1.
If the digital power supply circuit fail, the unit will not operate at all. Perform the diagnostic test in Section 5.2.2.

If either of the analog power supplies fails, the unit will not operate correctly. Specifically the pressure sensor circuit and the fail-safe circuits will be affected. Perform the diagnostic test in Section 5.2.3.

If the pressure-sensitive switches fail, the unit will not respond to key presses. Perform the diagnostic test in Section 5.2.4.

If the motor drive circuitry fails, the pump will either not operate or not operate within specifications. Perform the diagnostic test in Section 5.2.4.

If any of the test 5.2.2, 5.2.3, and 5.2.4 show that the power supply PCB is faulty, replace the power supply PCB following the procedure in Section 6.2. If the flex circuit is faulty, follow the procedure in Section 6.11.

5.2.1 (+) 5 VDC Digital Voltage Power Supply Diagnostics

To check the digital voltage power supply, the input power supply is set to 6.5V. Open up the unit following Steps 1 through 12 of the unit disassembly procedure (see Appendix 9.2). Reassemble the unit enough to power up and then measure the +5V digital supply DC voltage and ripple voltage from Pin 8 of J40 (main PCB header). The acceptable range of the DC voltage is between 5.02 to 5.44V and the ripple less than 0.2 Vpp. The input power supply is then set to 4.5V, and the same measurements are made. The acceptable range of the DC voltage is between 4.84 and 5.13V and the ripple less than 0.2 Vpp. The ripple is measured with an oscilloscope.

5.2.2 (+) 5 and (-) 5 VDC Analog Voltage Power Supplies Diagnostics

The analog power supplies must be turned on before testing. Open up the unit following Steps 1 through 12 of the unit disassembly procedure (see Appendix 9.2). Reassemble the unit enough to power up and then turn on the unit analog supplies. This can be done via the analog power up/down test located in the "Detailed Tests" menu. Check that the AON signal turns on and off with this test (Pin 6 of J40). Insure that the +5 VDC digital supply does not dip more than 100 mV at 6.5V when the analog power is turned on. The DC voltage and ripple voltage of both supplies are measured. This can be done by entering the "Valve 1 Test" mode. Neither analog supply should have an absolute DC value of less than 200 mV from the main +5V supply. The ripple voltage should not exceed 0.1 Vpp at 6.5V when measured with an oscilloscope.

5.2.3 PCB Electrical Switches Diagnostics

The power supply PCB switches should be checked by disassembling the unit and removing the keypad (perform the necessary steps in Appendix 9.2). The switches operate by being shorted by the conductive backing of the keypad. Reassemble the unit to the point at which the unit will operate but that the J40 header of the main board can be tested. Check the signal levels of Pins 1, 2, and 3 with the operational of the left, right, and middle keys respectively. Each channel should operate normally and without interaction from the other switch.

5.2.4 Motor Drive Circuitry Diagnostics

Disassemble the unit sufficiently to remove the unit's pump (see Appendix 9.2). Remove the pump and reassemble the unit sufficiently so that the unit can be powered up but that the motor drive circuitry header on the power supply PCB can be monitored. Start the unit up into the "Detailed Tests" menu and perform the "OvPress Test" and hold the button. This activates the motor drive circuit, and there should be 6 VDC between the motor drive terminals. If it isn't, check that the signal on Pin 4 of the J40 header should turn on and off with motor activation (it is an active low terminal).

5.3 Pressure Sensor

The pressure sensor monitors the manifold pressure and provides an electrical signal to the unit's A/D converter. The pressure sensor's sensor is connected in an electrical bridge design so that changes in pressure correspond to changes in voltage across the bridge. The pressure sensor signal is converted by the pressure sensor amplifier to a signal level readable by the unit A/D converter. Also associated with the pressure sensor is the tubing connecting it to the unit manifold.

If the pressure sensor or its tubing leak, the unit may either detect a leak during measurement cycles or will read pressure incorrectly. Check for this with the diagnostic test in Section 5.3.1.

If the pressure sensor or the pressure sensor amplifier have failed, the unit will not be able to read pressure correctly, which can result in autozero failures, fail-safe failures, or unit measurement failures. Check for this with the diagnostic tests in Section 5.3.2

If pressure sensor tubing leaks, replace it following the procedure in Section 6.10. If the pressure sensor leaks or if the pressure sensor does not read correctly, replace the main PCB following the procedure in Section 6.1.

5.3.1 Pressure Sensor And Tubing Leak Diagnostics

Connect the unit to the manual test station. Pressurize the unit to 250 mmHg. If the unit leaks, open up the unit and pinch off the pressure sensor tube with needle nose pliers. Re-pressurize the unit pneumatics. If the unit continues to leak, go to Section 5.13 and check the other internal pneumatics. If the pressure sensor or the pressure sensor tubing is leaking, gently remove the pressure sensor tubing from the pump. Pinch off the pressure sensor tubing at the end and re-pressurize the internal pneumatics. If the leak remains, replace the pressure sensor tubing following the procedure in Section 6.10. If the there is no leak, connect the external test pneumatics directly to the pressure sensor and recheck for leaks. If the pressure sensor itself leaks, replace the main PCB following the procedure in Section 6.1.

5.3.2 Pressure Sensor And Amplifier Diagnostics

Perform the pressure sensor functional test in Section 7.3. If the unit passes the product specifications in Document 126P157, the pressure sensor and amplifier circuit are OK. If the pressure sensor operation does not meet the unit specification, open up the unit just enough so that the pressure sensor tubing can be disconnected and replaced with a connection to an external 250 cc volume, a pressure source, and a calibrated pressure sensor. Reassemble the unit enough so that it operates. Repeat the pressure sensor functional test. If the pressure sensor does not read correctly, perform the test procedure described below. If the pressure sensor reading from the unit is still incorrect, check the + 4 VA reference for proper voltage (J21 of the main PCB). Also check J20 of the main PCB to see if its signal level changes with different pressures applied to the pressure sensor. If either of these checks are negative, replace the main PCB or the pressure sensor (see Appendix 9.2 for details).

ABPM Pressure Sensor Troubleshooting steps:

1. The following symptoms are indicative of the Pressure Sensor or it's associated circuitry failure.

   a. Unit will not Autozero.

   b. Unit reads a constant pressure i.e. +315, or -000

   c. Unit's pressure is highly inaccurate I.

   d. Unit reads 120mmHG at 300mmHG.

2. Although the symptoms can vary widely for Pressure Sensor failure the method for determining the failure and repairing it is always the same. These steps are:

   a)Place Unit in "Detailed Tests" mode and run "Valve1Test" (see Appendix 9.4). There is a 5 decimal place indication of pressure in this test and with no pressure input it should read =00006.

   b) If the pressure indication is off insure the Pressure Sensor is properly nulled by connecting a digital multimeter to pins 2 & 4 of the Pressure Sensor and adjust RP4 (see Drawing 125S205 for location) for a 0.0 VDC indication. If the Pressure Sensor can not be adjusted to 0.00 VDC there is a problem go to step f.

   c) After nulling the Pressure Sensor place the multimeter positive lead on J20 and the negative lead on pin 1 of the Pressure Sensor. Adjust RP3 (see Drawing 125S205 for location) for an indication of 50mv. Note: if the 50mv cannot be set, first check the +4 volt reference voltage at J21 and pin 1 of the Pressure Sensor. If this voltage is wrong than it must be adjusted or Troubleshot and repaired before you do any thing more with the Pressure Sensor.

   d) Input a calibrated 150 +/- 0.25 mmHg pressure to the Pressure Sensor and adjust RP2 for an indication of 150.38mmHG (This should give the best span results).

e) nput a calibrated 250 +/- 0.25 mmHg to the Pressure Sensor the pressure should read 250 +/- 1.5 mmHG. If it does not, than this particular Pressure Sensor does not have the range and it must be replaced. Go to step g.

f) If the Pressure Sensor will not be set to 0.00 VDC after performing step b, shut down unit. Measure the resistance between pin 2 of Pressure Sensor and pin 5 of IC chip U10. Measure resistance between pin 4 of Pressure Sensor and pin 12 of IC chip U10. Both of these measurements should indicate continuity. If either or both do not indicate continuity, than there is either a cold solder joint or the internal pad connections have broken. Return PCB to Tycos for replacement.

g) If after careful after performing steps a-e the Pressure Sensor reading is still out by more than +/- 1.5mmHG, than the Pressure Sensor should be replaced. See Section 9.3.5.

5.4 Internal Microphone Circuitry

The internal microphone circuitry consists of two parts: the microphone amplifier and the microphone receptacle. The microphone amplifier converts the signal from the microphone to a usable form to be converted by the unit's A/D converter. The unit microphone receptacle receives the 3 pin Lemo microphone plug which extends from the unit microphone (which is part of the unit's pneumatic assembly). The receptacle electrical conductors are connected to the main PCB through a Dupont connector.

If the microphone amplifier has failed, the unit will not detect Korotkoff sounds correctly (signal levels will either be too strong, too weak, or will not exist at all). Perform the diagnostic test in Section 5.4.1 to check the microphone amplifier. If amplifier has failed, replace main PCB (see Section 6.1).

If the microphone receptacle has failed, the unit will not detect Korotkoff sounds correctly (signal levels will either be too strong, too weak, or will not exist at all). Perform the diagnostic test in Section 5.4.2 to check the microphone receptacle. If receptacle is bad, replace (see Section 6.3).

5.4.1 Microphone Amplifier Diagnostics

Test the unit with its pneumatic assembly using the procedure in Section 7.10. If the unit fails this test, repeat the test with a known good pneumatic assembly (external microphone). If the unit does not fail this time, go to the microphone diagnostics section (Section 5.11).
If the unit continues to fail, then open the unit and visually check that the microphone Dupont connector is properly connected to the main PCB header (J6). If it is, remove it and connect a replacement microphone port receptacle into the microphone header. Connect the known good microphone to this substitute receptacle and repeat the test procedure in Section 7.9. If the test fails, the microphone amplifier circuit is failed and the main PCB needs to be replaced (see Section 6.1). If the test passes, perform the diagnostic test in Section 5.4.2 to check the microphone receptacle.

5.4.2 Microphone Receptacle Diagnostics

A possible failure may be that the microphone jack is stuck in the unit's microphone receptacle. Receptacle will need to be removed. If problem other than stuck plug, open the unit and visually check that the microphone port Dupont connector is correctly connected to the main PCB. If it is, disassemble the unit following Steps 1 through 12 of the unit disassembly procedure (Appendix 9.2). Disconnect the microphone receptacle Dupont connector from the main PCB. Using a multimeter and small gauge wire, check the electrical connections between the Dupont connector terminals and the microphone receptacle with ABPM Assembly Drawing 66S507. If there are no shorts or open conductors, reconnect the Dupont connector in the proper manner and retest using the diagnostic procedures in Sections 5.4.1 and 5.4.2. If the problem persists, replace both the microphone receptacle and the main PCB (see Sections 6.1 and 6.3).

5.5 LCD

The LCD module and its associated controller display unit messages and data on two lines of 16 characters each. Included with the LCD is the flex circuit that attaches it to the unit's main PCB.

If the LCD display, its controller module, or flex circuit fail, the result will be the unit not displaying anything at all, the unit segments/characters incomplete or upside down, or the display will show unknown characters or messages. Check for proper LCD function using the test procedure in Section 5.5.1.

If the LCD display or its controller module have failed, perform the repair procedure in Section 6.4. If the LCD flex circuit has failed, perform the repair procedure in Section 6.11.

5.5.1 LCD Diagnostics

Power up the unit in the normal fashion and watch the power up sequence. If all of the LCD segments flash on completely for a second, then the LCD works. If the display does not light up at all or not all segments of the display are black then something is wrong with the LCD, LCD controller module, or the LCD flex circuit that connects to the main PCB. Make sure the flex circuit between the LCD and the main PCB is connected correctly and completely. Recheck this before any other diagnostics.

If the LCD still does not operate, open up the unit following Steps 1 through 11 of the unit disassembly method in Appendix 9.2. Disconnect the LCD flex circuit from the unit's main PCB. Disassemble a known good unit following Steps 1 through 11 of the unit disassembly procedure in Appendix 9.2. Connect the failed LCD's flex circuit to the good unit's main PCB's LCD header. Reassemble this unit sufficiently so that it can be powered up and then power up the good unit. If the failed unit's LCD powers up correctly, then the failure is the failed unit's main PCB (for replacement, see Section 6.1). If not, connect the good unit's LCD and LCD flex circuit to the failed unit's main PCB's LCD header (make sure the header is connected properly) and then power up the unit. If the LCD powers up correctly, then the problem is either the failed unit's LCD or LCD flex circuit. Remove LCD flex circuit and connect it between the good unit's main PCB LCD flex header and the good unit's LCD. Power up the good unit. If its LCD works correctly, then go back and check the failed unit's LCD module and main PCB as described above. If the flex circuit fails, then replace the flex circuit (see Section 6.11). IF the LCD has failed, replace following the procedure in Section 6.4. Repeat the above tests as necessary to isolate the problem to another unit.

5.6 Keypad

The keypad is a soft molded rubber component with conductive material on back of keys. It serves as the external interface between the user and the power supply PCB's electrical switches. The keypad has two gray keys and one green key.

If the keypad fails, the unit will not respond properly to keypad presses. Perform the test in Section 5.6.1 to check for keypad failure.

5.6.1 Keypad Diagnostics

Check the response of the keypad by powering the unit up into the "Basic Parameters" menu. Try to set the unit time or date. If these commands can not be reached or if the unit is unable to change the time, then open up the unit following Steps 1 through 12 of the unit disassembly procedure (Appendix 9.2). Check the operation of the keypad by checking the electrical signals on Pins 1, 2, and 3 of the main PCB J40 header. If the unit fails this keypad test, continue to disassemble the unit until the keypad can be removed. Remove the keypad from the power supply PCB and then reassemble the unit to the point at which it can be powered up. Clean switches with isopropanol and allow to dry. Now repeat the keypad test described in the prior paragraph except directly short the switches located on the power supply PCB. If the unit operates correctly (responds to key presses), the keypad has failed. Otherwise, the power supply PCB, the power supply PCB's flex circuit, or the main PCB have failed.

5.7 Unit Serial Port Receptacle

The unit serial port receptacle receives the 5 pin Lemo serial plug which is part of both the PC connection cable and the unit printer connection cable. The receptacle's electrical conductors are connected to the main PCB header (J3) through a Dupont connector.

If the unit serial port receptacle fails, the unit will be unable to communicate properly through the serial port, which means that it may not print data or may print data incorrectly, it may be unable to communicate with the PC Diskette software, or it may not transmit data to PC Diskette software, or the data transmitted to the PC Diskette software may be incorrect. Perform the diagnostic test procedure in Section 5.7.1.

If the unit serial port receptacle fails, replace it following the procedure in Section 6.6.

5.7.1 Serial Port Receptacle Diagnostics

Connect the good unit to a compatible printer with a known good PC serial cable. Test the good unit's serial port with the printer test in the "Detailed Test" menu (see Appendix 9.4). This test sends a test pattern to the printer until the test is stopped manually. The pattern starts with one character on the first line, two on the second and so on. The space character is the first character sent. Upon reaching the eightieth line, the length of the line is set back to one and the pattern is restarted. This will take use about 1&1/3 pages of printer paper. The data character is not reset however, it is continuously incremented until reaching '~', then is reset to the space character. The speed at which the characters are sent is sufficient to over run the printer buffer, therefore testing the unit serial commands XOFF and XON. If the pattern doesn't stay regular then something is probably wrong with the printer setup. If the good unit and printer cable test OK, switch the good unit with the failed unit and repeat the printer test. If the failed unit does not print correctly, open up the unit following Steps 1 and 2 of the unit disassembly procedure (see Appendix 9.2). Visually check the serial port and see that it is connected properly. If it is connected properly, remove the serial port Dupont header from the connection to the main board. Obtain a known good serial port receptacle with Dupont header and connect it to the failed unit's main PCB serial header (J3). Repeat the printer test. If the unit now performs the test correctly, remove serial port receptacle from the unit and check for electrical continuity and proper connections (refer to the ABPM Assembly Drawing 66S508). Replace if the electrical connections are incorrect. If the electrical connections are correct but the serial port still does not operate correctly, replace the main PCB (see Section 6.1).

5.8 Main Battery Pack

The main battery pack provides the power which operates the unit. It is composed of 4 AAA batteries (1.5 VDC each) for a nominal combined voltage output of 6 VDC (this voltage can be expected to degrade as batteries are used). Rechargeable batteries will not supply adequate power for continuous operation of unit during ambulatory operation.

The main battery pack has three main failure modes: one or more of the batteries are electrically drained, the batteries are not inserted into the unit correctly or are not making proper contact with the unit electrical contacts (battery door and battery contact springs), or battery contact springs are not connected properly to power supply PCB.

If one or more of the batteries is electrically drained, the unit may display the "Battery Warning" message, the "Battery Failure" message, or it may not operate at all. Another sign of the battery failure is a faint or weak LCD display. Check this with the diagnostic procedure in Section 5.8.1.

If the batteries are not inserted properly into the unit or do not make proper electrical contact with the unit, the unit will turn on and off intermittently or may not operate at all. Check this with the diagnostic test in Section 5.8.2.

If the battery contact springs are not connected to the power supply PCB properly, the unit may display the "Battery Warning" message, the "Battery Failure" message, or it may not operate at all. Another sign of the battery failure is a faint or weak LCD display. Check this with the diagnostic test in Section 5.8.3.

5.8.1 Individual Battery Diagnostics

Remove the four batteries from the failed unit. Obtain a known good unit and four new (fresh) AAA batteries. Insert the good batteries properly into the good unit and confirm that it powers up correctly. Enter the battery voltage test in the "Detailed Tests" menu (see Appendix 9.4). The unit should display a battery voltage between 5.82 and 6.4 volts. If it doesn't, find another set of new batteries. Do not use rechargeable batteries. Rechargeable batteries do not provide adequate power for continuous ambulatory monitoring.

Now insert the good batteries into the failed unit. Enter the battery voltage test in the advanced diagnostics (see Appendix 9.4). The unit should display a battery voltage between 5.82 and 6.18 volts. Go to the diagnostic tests in Sections 5.82 and 5.83. Otherwise, remove one of the good batteries and insert one of the failed unit's original batteries. Recheck the unit's battery voltage as described above. If the unit voltage is below this level, discard the original battery. Repeat this test with all four of the failed unit's original batteries.

5.8.2 Battery Contact Diagnostics

Remove the four batteries from the failed unit. Obtain a known good unit and four new (fresh) AAA batteries. Insert the good batteries into the good unit and confirm that it powers up correctly. Enter the battery voltage test in the "Detailed Tests" menu (see Appendix 9.4). The unit should display a battery voltage between 5.82 and 6.4 volts. If it doesn't, find another set of new batteries.

Now insert the good batteries into the failed unit and close the battery door. If the unit powers up correctly, repeat the battery test described in the paragraph above and find the unit battery voltage. If it is out of range, perform the battery contact spring test in Section 5.8.3. If the unit does not power up, check that battery door to make sure that it has a metal contact plate and that the plate is not corroded or loose. Make sure that there is no foreign material inside the battery housing. Disassemble the unit if necessary to check this. Recheck unit. If it still fails, disassemble the unit following Steps 1 through 12 of the unit disassembly procedure (see Appendix 9.2). Connect electrical probes to the battery contact springs through the end slits in the battery cover. Insert new batteries and make contact across the end of the batteries with the battery door. If the connected voltage measuring device (either oscilloscope or multimeter) does not read near 6 VDC between the terminals, check that the batteries are inserted correctly and that the door plate is making contact with both sets of batteries. If the unit still does not work, perform the diagnostic procedures in Section 5.8.3.

5.8.3 Battery Contact Spring Diagnostics

Connect the adjustable DC power supply to the unit's battery contacts using either the custom battery insert or a set of alligator clips (when looking into the battery housing with unit right side up, the right battery contact spring is the negative terminal and the left battery contact spring is the positive terminal). Set the power supply to 6.0 VDC. If the unit powers up correctly, shut the unit down and repeat all of the battery diagnostics in this section (5.8). Check for corrosion that may indicate that the batteries may have leaked. If the unit continues not to operate correctly, check the power supply PCB (Section 5.2).

5.9 Lithium Battery

The lithium battery provides power to the unit SRAM and RTC so that unit data, parameters, date, and time are maintained when no power is supplied to unit from the main battery pack.

Failure of the lithium battery can result in loss of data in the SRAM and improper RTC operation. This means that the unit's control program or any stored unit data or parameters may be corrupted or destroyed. Any one of these occurrences can result in the unit not powering up or operating correctly or the unit displaying "Lithium Failure", "Clock Failure", or "Defaults Changed" messages. Perform the diagnostic test in Section 5.9.1 to check the lithium battery.

5.9.1 Lithium Battery Diagnostics

Remove main batteries before performing the following diagnostics. Disassemble the unit following Steps 1 through 12 of the disassembly procedure in Appendix 9.2. Use a multimeter to check the voltage between the lithium battery terminals as they are located on the board. If the voltage is +3 VDC (+/- 0.2 VDC), check the battery voltage at Pin 4 of U27 on the main PCB referenced to a "GND" terminal. If the voltage is the same at that point, then there is probably a main PCB failure (go to Section 5.1). If the voltage is different, then the lithium battery is not mounted correctly to the main PCB. Replace the lithium battery following the procedure in Section 8.3.

5.10 Printer Serial Cable

The printer serial cable connects the unit to an external printer so that data can be printed out.

Failure of the printer cable may cause the unit to be unable to print properly to an externally connected printer. To check for failure of the printer serial cable, perform the diagnostic procedure in Section 5.10.1.

5.10.1 Printer Serial Cable Diagnostics

Obtain a good unit and good printer serial cable. Connect the good unit with the good printer cable to an external printer that has been properly configured with the unit serial communication parameters (see ABPM Operator's Manual). Power up the unit and check to see if it contains any data. If it does not, disconnect the printer serial cable and perform a measurement cycle with the "Do Office Run" menu command. The unit should now contain data. Reconnect the printer cable and print out the data to the externally connected printer with the 'Print Data' command. The printer should now print out a unit report that matches the format shown in the ABPM Operator's Manual. If it does not, check that the electrical connections of the printer cable match the electrical connections shown on the ABPM Assembly Drawing 66S506. Check that the printer has been properly configured as described in operator's manual.

Once proper operation of the good unit is confirmed, repeat the above test with the failed unit and its printer serial cable with the good printer. If the failed unit now prints, the problem was not with unit or its cable, but was due to improper setup of the user's external printer. Consult with the user.

If the failed unit still does not print, connect the good unit and the good cable back up to the external printer and recheck for proper operation (this makes sure that any serial communication jams caused by the failed unit are cleared before further diagnostics). Once proper operation of the good unit is again confirmed, switch the good printer serial cable with the failed unit's printer serial cable. Attempt to print out the unit data again. If the good unit is able to print out data with the failed unit's cable, the problem is with either the failed unit's serial port receptacle or the serial port interface on the failed unit's main PCB. Check those items using the diagnostic procedures in Sections 5.1 and 5. 7. If the good unit is not able to print out with the failed unit's serial printer cable, then the serial printer cable is bad. If it the printer serial cable is bad, check that the electrical connections of the printer cable match the electrical connections shown on the ABPM Assembly Drawing 66S506. and repair the cable following the procedure in Section 6.13.

5.11 PC Serial Cable

The PC serial cable connects the unit to an external PC so that data and parameters can be exchanged between the unit and the PC Diskette Software (Part #5100-61 for the English model, Part #'s 5100-62 through 5100-65 for the foreign language models).

Failure of the PC cable may cause the unit to be unable to communicate properly to an externally connected PC running the PC Diskette software. To check for failure of the PC serial cable, perform the diagnostic procedure in Section 5.11.1.

5.11.1 PC Serial Cable Diagnostics

Obtain a good unit and good PC serial cable. Connect the good unit with the good PC cable to an external PC that has been properly configured with the PC Diskette Software and the unit serial communication parameters (see ABPM Operator's Manual). Power up the unit and check to see if it contains any data. If it does not, disconnect the PC serial cable and perform a measurement cycle with the "Do Office Run" menu command. The unit should now contain data. Reconnect the PC serial cable and read out the data to the externally connected PC with the PC Diskette software. If this operation is not performed correctly, check that the electrical connections of the PC cable match the electrical connections shown on the ABPM Assembly Drawing 66S504. Check that PC communications have been properly configured per operator's manual.

Once proper operation of the good unit is confirmed, repeat the above test with the failed unit and its PC serial cable connected to the external PC with PC Diskette Software. If the failed unit now reads out data to the PC Diskette software, the problem was not with the unit or its cable, but was due to improper setup of the customer's external PC. Consult with the customer.

If the failed unit still does not transmit data to the PC Diskette software, connect the good unit and the good cable back up to the external PC and recheck for proper operation (this makes sure that any serial communication jams caused by the failed unit are cleared before further diagnostics). Once proper operation of the good unit is again confirmed, switch the good PC serial cable with the failed unit's PC serial cable. Attempt to read out the unit data again to the PC Diskette software. If the good unit is able to read out data with the failed unit's cable, the problem is with either the failed unit's serial port receptacle or the serial port interface on the main PCB. Check those items using the diagnostic procedures in Sections 5.1 and 5. 7. If the good unit is not able to read out data with the failed unit's serial PC cable, then the serial PC cable is bad. If it the PC serial cable is bad, check that the electrical connections of the printer cable match the electrical connections shown on the ABPM Assembly Drawing 66S504. and repair following the procedure in Section 6.13.

5.12 Microphone

The microphone detects acoustic signals of the Korotkoff sounds from the patient's circulatory processes and transmits them to the unit as electrical signals.

Possible microphone problems include rusting of microphone head or the microphone plug becoming stuck in the microphone receptacle.

Because the failed microphone directly affects the measurement cycle of the unit, the following errors may result: unit detects Korotkoff sounds too weak, Korotkoff sounds too strong, no Korotkoff sounds, or unit does not measure blood pressure correctly. The microphone can be checked for failure with the diagnostic procedure in Section 5.12.1.

5.12.1 Microphone Diagnostics

Check the unit and its microphone using the functional test procedure in Section 7.10. If the unit and its microphone meet the product specifications given in Document 126P171, repeat the test. If the unit still meets the product specifications, then the unit is OK. If it does not, perform diagnostics on the main PCB as described in Section 5.1.

If the unit and its microphone do not pass the microphone functional test procedure of Section 7.10, do the following diagnostics. Obtain a good unit and good microphone and perform the functional test procedure in Section 7.10. If the good unit and good microphone meet the product specifications in Document 126P171, replace the good microphone with the microphone from the failed unit and repeat the microphone functional test. If the good unit and the failed unit's microphone meet the product specification, repeat the microphone functional test using the failed unit and the good microphone. If the good unit and the failed unit's microphone pass the test and the failed unit and the good microphone don't pass the test, the failure is in the failed unit's microphone receptacle or the main PCB (these can be checked with the diagnostic procedures in Sections 5.1 and 5.4). If the good unit and the failed unit's microphone do not pass the test and the failed unit and the good microphone do pass the test, then the failed unit's microphone is bad and should be replaced following the procedure in Section 6.13. If any other combination occurs, the functional tests need to be repeated until consistent test results emerge. If the failure is still unknown, replace the failed unit's microphone, microphone receptacle, and the main PCB (see Chapter 6 for the proper procedures).

(Pneumatic Component Diagnostic Tests)

5.13 Internal Pneumatics

The unit's internal pneumatics are composed of the following items:

1. **Valve**
2. **Valve Tubing**
3. **Pump**
3. **Pump Tubing**
4. **Pressure Sensor**
5. **Pressure Sensor Tubing**
6. **Manifold And Gasket**

Failure of the internal pneumatics can result in the unit not being able to inflate the occluding cuff, not being able to maintain a pressure in the occluding cuff, not being able to monitor pressure in the occluding cuff, not being able to deflate properly, or some other improper pneumatic operation. If a leak occurs in the internal pneumatics, determine which components have possibly failed by performing the diagnostic procedure in Section 5.13.1.

The valve opens and closes to release pressure as needed from the unit's pneumatic system. Valve failures include the valve either not completely closing, not completely opening, or not closing at all. If the valve does not close properly, the unit pneumatics will leak pressure. If the valve does not completely open, it will not dump pressure fast enough (will not meet product specification of Document 126P171). The valve tubing pneumatically connects the valve to the unit manifold. A leak in the valve tubing will cause the same problem as the valve not closing properly. An obstruction in the valve tubing will cause the same problem as the valve not opening properly. (See Sections 5.17 and 5.18)

The pump inflates the volume of the unit's pneumatic system to a designated pressure value. Pump failures include the pump not operating fast enough, the pump leaking pressure, and the pump not operating at all. One failure cause is loose connection or disconnected. The pump tubing pneumatically connects the pump to the unit manifold. A leak in the pump tubing will cause the same problem as the pump leaking. An obstruction in the pump tubing will cause the same problem as the pump not operating fast enough or not operating at all.

The pressure sensor monitors the pressure of the unit's pneumatic system. Failure of this component results in the improper unit pressure values or leaking pressure from the unit's pneumatic system. Go to Section 5.3 to perform diagnostics of the unit pressure sensor and its tubing.

The manifold and gasket serve as a pneumatic interface between the valve, the pump, the pressure sensor, and the unit's external pneumatics.

If the unit leaks, follow the diagnostic procedure in Section 5.13.1.

If the unit does not inflate properly, follow the diagnostic procedure in Section 5.13.2.

If the unit does not deflate properly, follow the diagnostic procedure in Section 5.13.3.

5.13.1 Internal Pneumatics Leak Diagnostics

Connect the unit up with the setup shown in Figure 7.1 of this manual except omit the unit's pneumatic assembly and directly connect to the unit's pneumatic port. Also, replace the unit's 250 cc volume with a 100 cc calibrated volume to test for leaks. Power up the unit into the "Detailed Tests" menu (see Appendix 9.4) and select Valve Test 1. The unit valve will close as long as the unit remains in the "Valve 1 Test" and is not pressurized over 10 mmHg for more than 3 minutes (if this occurs, just restart the valve test). Apply a pressure of 250 mmHg to the unit and then turn off the high pressure source. Allow the unit to stabilize for 10 seconds. If the unit leaks significantly (see product specification in Document 126P171), there is an internal pneumatics leak. If it does not leak, repeat the test with a pressure of 150 mmHg. If there is still no leak, check the unit's external pneumatics for leaks (see Section 5.14).

If the unit internal pneumatics leak at either pressure, open up the unit following the Step 1 of the disassembly procedure in Appendix 9.2. Apply 250 mmHg pressure to the unit again and then turn off the pressure source. Pinch off the pressure sensor tubing, the valve tubing, and the pump tubing one at a time to see which component is leaking.

If the pressure sensor is leaking, perform the diagnostic procedures in Section 5.3.

If the valves or the valve's tubing is leaking, gently remove the valve tubing from the valve. Pinch off the valve tubing at the end and re-pressurize the internal pneumatics. If the leak remains, replace the valve tubing following the procedure in Section 6.10. If it doesn't, replace the valve following the procedure in section 6.7A if it is the control valve or 6.7B if it is the dump valve.

If the pump or the pump tubing is leaking, gently remove the pump tubing from the pump. Pinch off the pump tubing at the end and re-pressurize the internal pneumatics. If the leak remains, replace the pump tubing following the procedure in Section 6.10. If the there is no leak, replace the pump following the procedure in Section 6.8.

If the leak cannot be stopped by pinching off the pressure sensor tubing, valve tubing, or pump tubing, the leak is in the manifold and gasket. Replace these items using the procedure in Section 6.9.

5.13.2 Valve Diagnostics

See Sections 5.17 and 5.18.

5.13.3 Pump Diagnostics

If the unit does not inflate properly, do the following steps. Open the unit following Step 1 of the disassembly procedure in Appendix 9.2. Visually check that the pump is electrically connected to the power supply PCB. If it is not, connect it properly and retest the unit for proper inflation (see Section 7.1). If it is connected correctly, remove the pump from the unit following Steps 1 through 14 of the disassembly procedure in Appendix 9.2. Use alligator clips and small conductor wire to electrically connect the adjustable DC power supply to the pump electrical connector (red conductor to the positive (+) terminal, black conductor to the negative (-) terminal. Pneumatically connect the pump to the 250 cc calibrated volume and the calibrated pressure sensor. Apply a positive 6 VDC voltage between the positive and negative pump conductors. If the pump does not operate at all, check the electrical contacts and repeat the test. If the pump fails again, replace the pump. If the pump passes, then replace it in the unit and retest the unit with the inflate functional test (see Section 7.1). If pump does not work in the unit, check the power supply PCB's motor drive circuit with the procedure in Section 5.2.4.

If the pump turns on but does not inflate or does not inflate fast enough, replace the outlet tubing. Repeat test. If it fails, replace the inlet tubing. If this fails, replace the pump. Follow directions in section 6.8.

5.14 External Pneumatics

The external pneumatics includes both the unit's pneumatic assembly and the bladder that is located inside the occluding arm cuff.
Obstructions or leaks in the external pneumatics can cause the unit not to operate properly including not autozeroing and not perform measurement cycles properly. Perform the diagnostics in Section 5.14.1 to check for external pneumatics failure.

5.14.1 External Pneumatics Diagnostics

Connect the external pneumatics to the high pressure source and calibrated pressure sensor. Apply 250 mmHg of pressure to the pneumatics. If the cuff does not inflate, remove the pneumatic assembly and reapply pressure directly to the cuff. If the cuff still does not inflate, replace the cuff following the procedure in Section 6.13. If the cuff does inflate, replace the pneumatic assembly following the procedure in Section 6.13.

If the cuff inflates properly then close off the pressure source. If there is a leak, remove the pneumatic assembly and apply pressure directly to the bladder. If the bladder leaks, replace it following the procedure in Section 6.13. If the bladder does not leak, replace the pneumatic assembly following the procedure in Section 6.13.

If the external pneumatics inflate properly and do not leak, check the unit's internal pneumatics for failures with the diagnostic procedures in Section 5.12.

5.15 Control Software

The unit's control software is stored in the unit's ROM and it is responsible for performing all of the unit's functions, including power on self test, message displays, key press response, and controls all the unit's electrical components. Note that there are different software versions for the QuietTrak and Tenso24 models.

If a unit contains the wrong version of control software, replace it following the procedure in section 8.1 This may also require updating the unit's power supply and main PCB's as described in Chapter 8.

A failure of the control software will usually mean that the unit will not operate at all, but there are instances where the unit will remain in operation but will not operate properly. NOTE: IT IS VERY IMPORTANT THAT ANY IMPROPER SOFTWARE OPERATIONS BE REPORTED TO TYCOS INSTRUMENTS IMMEDIATELY. A diagnostic procedure for the control software is in Section 5.15.1

5.15.1 Control Software Diagnostics.

Power up the unit and observe the power up display. Confirm that it matches the expected power up display described in the ABPM's Operator Manual. If it does not, reload the unit control software following the procedure in Section 8.1. Repeat the power up test. If the unit fails again, replace the main PCB following the procedure in Section 6.1.

5.16 Improper Operation/Programming

Most of the unit's operation require an exact sequence of user input and unit responses to function properly. There will be instances where a unit does not function as expected due to improper operation or programming from the user. Below is a list of these possible occurrences and the unit operation items to be checked when they occur. Refer to the ABPM Operator' s Manual for proper operation and programming methods.

Unit Does Not Power Up, Nothing Displayed
Check that batteries are good and are inserted properly in the unit. Check that rechargeable batteries are not being used.

Unit Displays Unknown Message or Symbols
Read through all of the ABPM Operator Manual's chapters to confirm that display is not part of operating messages. Unit in "auo" mode.

Unit Displays 'Autozeroing Failure'
Unit pneumatics may have been externally disturbed during autozero test. Remove external pneumatics from unit and power unit up again to confirm that there is no autozero failure.

Unit Displays 'Battery Failure' or 'Battery Warning'
Check that fresh batteries have been installed in unit. Check that rechargeable batteries are not being used.

Unit Displays 'Defaults Changed' Message
Loading new software will cause 'Defaults Changed' message to appear when unit restarted. Re-power up unit. Message should not reappear.

Unit Displays Only Date And Time
Check that unit is not in "auto" mode and that the unit display has not been turned off.

Unit Displays Incorrect Date/Time
Set unit time as described in ABPM Operator's Manual and check 5 minutes later. If time is off significantly, check the unit's RTC on the main PCB.

Unit Does Not Respond To Button Presses At All Or During Certain Commands
Check that unit is not in a measuring interval and that the button activation has not been turned off.

Unit Does Not Display All Selections
Unit will not display any data commands (Display Data, Print Data, Erase Data) if unit does not contain data. (see Section 4.18)

Unit Displays '1 Day Max Limit' Message Or '300 RDG Limit' Message
Unit's measurement intervals and readings have exceeded the unit's limits. Print out the data and then erase all of the unit data and reprogram measurement interval.

Unit Will Not Perform Measurement Cycle (see Section 4.21)
Unit not properly programmed or connected. May be using weak or rechargeable batteries. Pneumatic hosing may be kinked or blocked. Large arm patient and large cuff. Excessive arm movement or cuff squeezed. Microphone not properly placed. See ABPM Operator's Manual.

Unit Displays 'Printer/PC Cable Connected' Message When Attempting Measurement Cycle
Disconnect PC or Printer serial cable from unit before attempting measurement cycle.

Unit Displays Error Code After Measurement Cycle (see Section 4.23)
Unit not properly programmed or connected or there is a problem with the external pneumatics. May be using weak or rechargeable batteries. See ABPM Operator's Manual.

Unit Performs Measurement Cycle But Data Incorrect
Unit not programmed properly or not connected to patient properly. Check placement of unit microphone and cuff.

Data Does Not Print Or Read Out Data Correctly To External Printer/PC
Unit serial cable incorrect. Printer/PC serial parameters incorrect. Check that unit and PC/printer are connected properly. Printer or PC not properly configured or using wrong connect cable. PC software not configured properly.

5.17 Control Valve

Any time a valve failure happens, follow the steps in section 6.7A and replace the control valve.

5.18 Dump Valve

Any time a valve failure happens, Follow the steps in section 6.7B and replace the dump valve.

CHAPTER 6:

Unit Repair Procedures

Chapter 6: Unit Repair Procedures

The following list contains the repair and replacement procedures for the unit components which can be repaired and/or replaced:

1. **Main PCB Replacement (see Section 6.1)**
2. **Power Supply PCB Replacement (see Section 6.2)**
3. **Unit Microphone Receptacle Repair (see Section 6.3)**
4. **LCD Replacement (see Section 6.4)**
5. **Keypad Replacement (see Section 6.5)**
6. **Unit Serial Port Receptacle Repair (see Section 6.6)**
7. **Valve Replacement (see Section 6.7A & B)**
8. **Pump Replacement (see Section 6.8)**
9. **Manifold Replacement (see Section 6.9)**
10. **Internal Hose Replacement (see Section 6.10)**
11. **Miscellaneous Internal Parts Replacement (see Section 6.11)**
12. **Unit Housing(s) Replacement (see Section 6.12)**
13. **Miscellaneous External Parts Replacement (see Section 6.13)**

The following repair procedures should be performed on grounded bench mat and the repair personnel should use a personal grounding strap. The repair equipment listed in Chapter 2 is required to perform these repair procedures in addition to the necessary replacement parts (listed in Appendix 9.6).

All repair procedures performed on a unit must be recorded on a unit data sheet (see Appendix 9.1) which must be maintained at the ABPM service center and be reported to Tycos Instruments.

If any internal unit component is repaired or replaced, the unit operation must afterwards be completely verified before being returned to the customer. This means that the unit must be tested with every functional test procedure listed in Chapter 7 and that the unit's test result be within the product specifications given in Document 126P171.

6.1 Main PCB Replacement

Component Function

The main PCB board contains the unit's microprocessor, serial port controller, real time clock (RTC), watch dog timer (WDT), random access memory (RAM), read only memory (ROM), analog to digital (A/D) converter, microphone amplifier circuitry, pressure sensor, pressure sensor amplifier circuitry, dynamic pressure circuitry, power down circuitry, over 10 mmHg fail-safe latch, pump operation fail-safe latch, over pressure detection circuitry, the +2 VDC voltage reference, the +4 VDC voltage references, the piezo valve power supply circuitry, and the lithium battery backup circuitry.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 11 of Appendix 9.2 and aside failed main PCB.
2) Obtain replacement main PCB and attach lithium battery if it does not have one (see Section 9.3.2 for directions). See Section 9.3.5 for pressure sensor replacement/recalibration. Record replacement PCB identification number on the corresponding location of the unit data sheet (Appendix 9.1). **NOTE: Main PCB must be REVISION C1 or higher.**
3) Reassemble unit following Steps 30 through 46 of Appendix 9.3 (skip Step 31).
4) Check that unit control software is latest version (2.60, 4.20 for QuietTrak or 2.62, 4.21 for Tenso24). Load new unit control software if not latest version (follow procedure in Section 8.1). Reload unit serial number also.
5) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
6) If unit meets all product specifications, return unit to customer.
7) Return failed main PCB to Tycos Instruments with detailed explanation of failure and copy of unit data sheet.

6.2 Power Supply PCB Replacement

Component Function

The power supply converts the power supplied by the main battery pack to a positive (+) 5 VDC digital supply voltage which is in turn converted into positive (+) 5 VDC analog power supply and (-) 5 VDC analog power supply voltage supply. The power supply PCB also contains the pressure-sensitive switches which interface to the keypad, the motor drive circuitry that powers the unit's pump during inflation, and the flex circuit that connects it to the main PCB.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 11 and Steps 13 through 22 of Appendix 9.2 and aside failed power supply PCB.
2) Obtain replacement power supply PCB. Record replacement PCB identification number on the corresponding location of the unit data sheet (Appendix 9.1). **NOTE: Main PCB must be REVISION B or higher.**
3) Reassemble unit following Steps 1 through 7 and Steps 22 through 46 of Appendix 9.3 (skip Steps 31 and 33).
4) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
5) If unit meets all product specifications, return unit to customer.
6) Return failed power supply PCB to Tycos Instruments with detailed explanation of failure and copy of unit data sheet.

6.3 Unit Microphone Receptacle Replacement

Component Function

The unit microphone receptacle receives the 3 pin Lemo microphone plug which extends from the unit microphone (which is part of the unit's pneumatic assembly). The receptacle electrical conductors transmit the microphone signal to the main PCB through a Dupont connector.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 12 of Appendix 9.2 and aside failed microphone receptacle.
2) Obtain replacement microphone receptacle (with ground lug (see Section 9.3.4) and Dupont connector attached) and reassemble unit following Steps 30 through 46 of Appendix 9.3 (skip Step 33). Check mating of receptacle and microphone plug.
3) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
4) If unit meets all product specifications, return unit to customer.
5) Discard failed microphone receptacle.

6.4 LCD Replacement

Component Function

The LCD module and its associated controller display unit messages and data on two lines of 16 characters each.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 11 and Steps 13 through 24 of Appendix 9.2 (skip Steps 19 and 21 through 24).
2) With front housing inverted, use small blade screwdriver to gently pry the top edge of the LCD window from the unit front housing. Window is attached with adhesive to housing, so extra force may be required to remove window. BE CAREFUL NOT TO SCRATCH OR CRACK EXTERIOR OF UNIT FRONT HOUSING.
3) Obtain replacement LCD and LCD Window and perform Steps 10 through 18 of Appendix 9.3.
4) Reassemble unit following Steps 21 through 46 of Appendix 9.3 (skip Steps 31 and 33).
5) Power up unit and check that LCD display flashes on completely during unit startup. Perform all procedures in Chapter 7 and record unit data on unit data sheet.
6) If unit meets all product specifications, return unit to customer.
7) Discard failed LCD and window.

6.5 Keypad Replacement

Component Function

The keypad is a soft molded rubber component which serves as the interface between the user and the power supply PCB's pressure-sensitive switches. The keypad has two gray keys and one green key.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 11 and Steps 13 through 21 of Appendix 9.2 and aside failed keypad (skip Step 19).
2) Obtain replacement keypad and reassemble unit following Step 7 and Steps 22 through 46 of Appendix 9.3 (skip Steps 31 and 33).
3) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
4) If unit meets all product specifications, return unit to customer.
5) Discard failed keypad.

6.6 Unit Serial Port Receptacle Replacement

Component Function

The unit microphone receptacle receives the 5 pin Lemo serial plug which is part of both the PC connection cable and the unit printer connection cable. The receptacle's electrical conductors transmit the serial signal to the main PCB through a Dupont connector.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 11 and Steps 13, 14, and 16 of Appendix 9.2 and aside failed serial port receptacle.
2) Obtain replacement unit serial port receptacle (with ground lug) (see Section 9.3.3) and Dupont connector) and reassemble unit following Steps 24 through 46 of Appendix 9.3 (skip Steps 26, 31, and 33).
3) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
4) If unit meets all product specifications, return unit to customer.
5) Discard failed serial port receptacle.

6.7A Control Valve Replacement

Component Function

The control valve opens and shuts in order to control the unit's pneumatic pressure at a constant level.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 11 and Steps 13 and 23 of Appendix 9.2 and aside failed valve.
2) Obtain replacement valve subassembly and record valve number on the corresponding location of the unit data sheet.
3) Reassemble unit.
4) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
5) If unit meets all product specifications, return unit to customer.
6) Return failed valve to Tycos Instruments and a copy of data sheet.

6.7B Dump Valve Replacement

Component Function

Component opens to deflate the units pneumatic pressure.

Replacement procedure

1) Follow the disassembly steps 1 thru 11.
2) Un-solder the dump valve and obtain replacement valve. Record valve number on the corresponding location of the unit data sheet.
3) Re-solder the dump valve in to place.
4) Reassemble unit.
5) Perform all procedures in Chapter 7.
6) If unit meets all specifications, return to customer.
7) Send defective valve to Tycos along with data sheets.

6.8 Pump Replacement

Component Function

The pump is responsible for inflating the unit's pneumatics.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 11 and Steps 13 and 14 of Appendix 9.2 and aside failed pump.
2) Obtain replacement pump subassembly (see Section 9.3.4)and reassemble unit following Steps 25 through 46 of Appendix 9.3. (skip Steps 26, 31, and 33)
3) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
4) If unit meets all product specifications, return unit to customer.
5) Return failed pump to Tycos Instruments and a copy of unit data sheet.

6.9 Manifold Replacement

Component Function

The manifold serves as an pneumatic interconnection for the unit's valve, pump, pressure sensor and external pneumatic port which attaches to the occluding arm cuff.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly Steps 1 through 7 of Appendix 9.2 and aside failed manifold and gasket.
2) Obtain replacement manifold and gasket and reassemble unit following Steps 30 through 44 of Appendix 9.3 (skip Steps 31, 33, and 34).
3) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
4) If unit meets all product specifications, return unit to customer.
5) Discard failed manifold and gasket.

6.10 Internal Hose Replacement

Component Functions

The internal hoses are used to pneumatically connect the unit's pressure sensor, valve, and pump to the unit's manifold.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the disassembly necessary to remove the failed tubing (pressure sensor tubing: Steps 1 through 4; pump intake or outlet tubing: Steps 1 through 14, skip Step 12; valve tubing: Steps 1 though 14 and remove valve tubing, skip Step 12).
2) Obtain appropriate replacement tubing (see replacement parts list in Appendix 9.6).
3) Reassemble unit as required by disassembly procedure in Step 1 (pressure sensor tubing: Steps 35 through 46; pump intake or outlet tubing: Steps 27 through 46, skip Steps 31 and 33; valve tubing: Steps 21 through 46, skip Steps 26, 31, and 33).
3) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
4) If unit meets all product specifications, return unit to customer.
5) Discard failed tubing.

6.11 Miscellaneous Internal Parts Replacement

Component Functions

This section covers the replacement of the following miscellaneous internal components: flex circuits, battery housing cover, battery contact springs, battery orientation labels, lithium battery insulating labels, battery door springs, and any miscellaneous internal screws. Refer to the ABPM Hardware Specification for the particular function of any unit component.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

1) Follow the necessary disassembly steps of Appendix 9.2 until failed part is removed.
2) Remove or repair failed part.
3) Reassemble unit following appropriate steps in Appendix 9.3.
4) Perform all procedures in Chapter 7 and record unit data on unit data sheet.
5) If unit meets all product specifications, return unit to customer.
6) Discard failed parts.

6.12 Unit Housing(s) Replacement

Component Function

Contains, connects, and protects unit circuitry and major components.

Replacement Procedure

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP.

NOTE: The housings should have metallized spray coatings on their interiors.

NOTE: Make sure that proper housing colors are used for QuietTrak (black) and Tenso24(gray) units. See Replacement Parts list in Appendix 9.6.

1) Follow the disassembly Steps 1 through 12 of Appendix 9.2 for rear housing replacement and Steps 1 through 24 (skip Step 13) of Appendix 9.2 for front housing replacement.

2) If replacing front housing, obtain replacement front housing, replacement LCD module, and replacement LCD window. If replacing rear housing, obtain replacement rear housing.

   Reassemble unit following Steps 1 through 46 of Appendix 9.3 for front housing replacement and Steps 30 through 46 of Appendix 9.3 for rear housing replacement (be sure to record old and new bar code label serial numbers on unit data sheet).

3) Perform all procedures in Chapter 7 and record unit data on unit data sheet.

4) If unit meets all product specifications, return unit to customer.

5) Discard damaged housing(s).

6.13 Miscellaneous External Parts Repair/Replacement

Repair and replacement of external ABPM parts is done by replacement. The following is a complete list of all external ABPM parts (does not include ABPM accessories): bumpers, bar code label, battery door, housing screws.

CHAPTER 7:

Unit Function Test Procedures

Chapter 7: Unit Function Test Procedures

If any internal unit component is repaired or replaced, the unit operation must afterwards be completely verified before being returned to the customer. This means that the unit and its associated pneumatic interface must be tested with every functional test procedure listed below and that the unit's test results be within the product specifications given in Document 126P171. Repair unit test specifications will be same as production specification unless noted different in Document 126P171.

The following list contains all of the functional tests required to confirm proper unit operation before returning a repaired or serviced unit to the customer:

1. **Inflate/Deflate Test (see Section 7.1)**
2. **Leak Test (see Section 7.2)**
3. **Pressure Sensor Test (see Section 7.3)**
4. **Unit Main Battery Voltage Test (see Section 7.4)**
5. **Pump Operation Latch/Overpressure Fail-safe Test (see Section 7.5)**
6. **Over 10 mmHg Fail-safe Latch Test (see Section 7.6)**
7. **Pinched Tube Test (see Section 7.7)**
8. **Dump Test (see Section 7.8)**
9. **Unit Power Test (see Section 7.9)**
10. **Microphone Circuitry Functionality Test (see Section 7.10)**
11. **Unit Print Test (see Section 7.11)**
12. **Final Parameters Procedure (see Section 7.12)**

All information gathered during any of the above functional tests must be recorded on a unit data sheet (see Appendix 9.1) and maintained in the ABPM service center's records.

Each of this chapter's test procedure will list the hardware and software necessary to complete the procedure. All of the test equipment is completely specified in Appendix 9.6. Unless otherwise specified, the unit should always be operated with a 6.5 VDC supply voltage. (See Block Diagram of ABPM Equipment for set-up).

7.1 Inflate Test/Deflate Test

Description

Determine that the unit inflates a standard volume within the specified amount of time and that the pump noise during inflation is not excessive.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

a 250cc volume is required for this test. In addition, a calibrated timer is also required. The unit control software is the software required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Connect the unit to be tested to the repair station. Power unit up and allow the unit to boot up. Go through the menu until the screen states "set parameters." Say "yes" to that statement and "no" to "set periods." Press "up" until the "maximum press" reads **270.** Continue to hit "next" once this is done until "do office run" is on the LCD display. **Clamp off the 100cc, 500cc volumes.** Press "yes" and at the same time press "start" on the unit and start the timer. Confirm that the units inflation time is within specifications.

2. Reset the timer. Visually **observe** the **deflation from 270 mmHg to 250 mmHg** to insure the unit is not "stair steeping." **Start** the timer **at 250 mmHg** and then **stop** the timer **when the unit falls below 40 mmHg.** Confirm that the deflation time is within specifications.

7.2 Leak Test

Description

Determine that unit internal pneumatics and external pneumatic assembly do not leak more than product specifications.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

100 cc calibrated volume is required for this test. In addition, a calibrated timer is also required. The unit control software is the software required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Remove power and then power up unit holding down the two gray buttons. Do this until the LCD screen states **"detailed test."** At that point, quickly release the two gray buttons and press the green button down until the unit states **"beginning test."** At this point, say **"yes" t**o the **"valve1 test."** Set the timer for **15 seconds. Remove the clamp from the 100cc volume and place on the 250cc volume.** Pump the bulb up until the meter states that the **pressure is above 250 mmHg.** Wait for **15 seconds** to allow the pressure to stabilize. Start the timer. Confirm that leak is within specifications.

2. Release the **pressure down to 50 mmHg.** Wait for **15 seconds** to allow the pressure to stabilize. Set the timer for 15 seconds. Start the timer. Confirm that leak is within specification. Once this test is complete, release the pressure to zero.

7.3 Pressure Sensor Test

Description

Determine that the unit's pressure sensor is calibrated and operating correctly. Pressure sensor tested while un-pressurizing downwards at 250 mmHg, 150 mmHg, 50 mmHg, and 0 mmHg.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

A 500cc volume is required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Remove the clamp from the 500cc volume and place it on the 100cc volume. Pump the bulb until the meter states that the pressure is **250 mmHg +/- 5 mmHg.** Wait for **15 seconds** to allow the pressure to stabilize. Look at the LCD screen. Confirm that the 250 mmHg reading is within the specifications. Release pressure until the meter reads **150 mmHg +/- 5 mmHg.** Wait for **15 seconds** to allow the pressure to stabilize. Look at the LCD screen. Confirm that the 150 mmHg reading is within specifications. Release pressure until the meter reads **50 mmHg +/- 5 mmHg.** Wait for **15 seconds** to allow the pressure to stabilize. Look at the LCD screen. Confirm that the 50 mmHg reading is within specification. Release pressure until the meter reads **0 mmHg +/- .3 mmHg.** Look at the LCD screen. Confirm 0 mmHg reading is within specifications.

7.4 Unit Main Battery Voltage Test

Description

Check that unit properly detects battery voltage levels and that unit digital voltage supply level correct.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

The only hardware required for this test is the adjustable power supply, the custom battery insert, and two digital multi-meters. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Hit one of the gray buttons to get you back to the menu. Hit **"no"** until the LCD screen says **"battery test."** Press the gray button above "yes." Adjust the power supply to **3.5 VDC +/- .02 VDC.** Look at the LCD display. Confirm that the unit reads the voltage within specification. Once test is completed set the power supply back to 6.5 VDC.

7.5 Pump Operation Fail-safe Latch/Overpressure Fail-safe Test

Description

Checks that the unit's fail-safe circuitry shuts the unit's pump off after 80 seconds of continuous operation.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

A 500cc volume is required for this test. In addition, a calibrated timer is also required. The unit control software is the software required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Hit one of the gray buttons to get you back to the menu. Hit **"no"** until the LCD screen says **"ovpress test."** At this time, **reset the timer.** Then at the same time press **"yes"** on the unit and hold that button down and start the timer. You must hold the button down on the ABPM unit until the test is complete. Confirm the over pressure fail-safe activates within specification. Check the maximum (peak) pressure value during the test. Confirm the peak pressure value is within specification.

7.6 Over 10 mmHg Fail-safe Latch Test

Description

Check that unit's Over 10 mmHg fail-safe latch activates properly when the unit is pressurized over 10 mmHg for more than 240 seconds.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

A 500cc volume is required for this test. In addition, a calibrated timer is also required. The unit control software is the software required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Press the gray button above **"no"** until the unit **reads "valve1 test."** Press the gray button above **"yes"** and reset the timer. Pump the bulb until the pressure is above **75 mmHg +/- 5 mmHg.** Once above 75 mmHg start the timer. Confirm that the units over 10 mmHg fail-safe circuitry activates within specification.

7.7 Pinched Tube Test

Description

Check that unit pneumatic tubing not pinched or kinked. This is verified by checking dynamic response of unit pressure Sensor to external pressure pulses.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

A 250cc volume is required for this test. In addition, a calibrated timer is also required. The unit control software is the software required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1) Press the green button until the unit reads "valve 1" test again. Press the gray button above "yes" to close the valve. **Clamp off the unit from the volumes** and remove the clamp from the 250cc volume and place it onto the 500cc volume. **Pump bulb** until pressure reads **250 mmHg +/- 5 mmHg on Setra meter. Wait 15 second to allow pressure to stabilize. Un-clamp the hose to the unit** and observe the LCD. **Wait 5 seconds, open valve of bulb.** Confirm that the unit meets specification.

7.8 Dump Test

Description

Check that unit valve releases specified pressure from calibrated volume within specified time limit.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

a 250cc volume is required for this test. In addition, a calibrated timer is also required. The unit control software is the software required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Remove power and then power up unit holding down the two gray buttons. Do this until the LCD screen states **"detailed test."** At that point, quickly release the two gray buttons and press the green button down until the unit states **"beginning test."** At this point, say **"yes"** to the **"valve1 test."** Press the gray button above "yes." This must be done in order to close the valve. Pump the bulb until the **meter reads 260 mmHg +/- 5 mmHg.** Wait for **15 seconds** to allow the pressure to stabilize. Reset the timer. At the same time, press the green button and start the timer. Confirm that the dump time is within specification. The unit will also be in its regular menu when you finish this test.

7.9 Unit Power Tests

Description

Check that the amount of current drawn from unit under the following three conditions is normal: asleep, awake, and with pump operating modes. Determine the battery voltage at which the unit quits functioning.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

Power supply, custom battery insert, two multi-meters and a printer or PC cable for the ABPM. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Connect a digital meter in series with the power supply and the unit. Allow the unit to **set for 15 - 40 seconds.** Note the current reading of the unit. There must be no out side connections to the unit during this test (i.e. PC cable). The unit also wakes up for one second every minute in this asleep mode. Confirm that the asleep mode current is within specification.

2. Awake mode is established when the printer cable is plugged into the unit and communications are established. Confirm that the current reading is within specification.

7.10 Microphone Circuitry Functionality Test

Description

Check that the unit's internal microphone circuitry and associated microphone pneumatic assembly operate properly together at different unit gain settings and different input frequency levels.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

A 250cc volume is needed for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Connect power to the unit and wait until the unit reads "Set Patient ID?" or "Review Data." Press the green button until the unit reads "Do office run?" Hook unit up to the test station's pneumatics and make sure that the 100cc volume and the 250cc volume are clamped off. Connect a known good microphone to the unit's limo connector laying the microphone itself on the ESD mat beside the ABPM. Press the gray button above "yes" then press the green button. The unit will inflate to the pre-set pressure that is programmed into its parameters. Observe the Setra meter, when the pressure is around 130 mmHg begin taping the ESD mat beside the microphone. (DO NOT TAP THE CASE, THIS CAUSES A ERROR IN THE UNIT) When the pressure reaches 80 mmHg, stop taping the ESD mat.

2. This may need to be done 2 or 3 times to allow the ABPM to adjust it's gain to the sounds that you are making on the mat. Once the unit begins returning readings, repeat the procedure a total of 2 more times.

3. If this procedure fails to return a reading, do a total of three office runs on your arm to insure that the unit is taking readings.

7.11 Unit Print Test

Description

Check that unit properly detects electrical connection to printer.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Required Initial Hardware and Software Conditions

A printer and printer cable for the ABPM is required for this test. (see Block Diagram for ABPM Equipment Set-Up)

Test Procedure

1. Connect the unit to a serial port printer. Go to "print data" and press the button above "yes." The unit will print out the information from the office runs in the microphone tests.

7.12 Final Parameters Procedure

Description

Return unit parameters to default value. Load unit serial number into the unit's EEPROM if not previously loaded. Erase any data stored in the unit. Check functional operation of unit's LCD and keypad.

Current Product Specifications

Consult Document 126P171 for the applicable specification for this unit functional test.

Hardware and Software Setup Required for Test

No special hardware/software is need for this test

Test Procedure

1. Remove power and re-power the unit holding down the first gray button until the unit reads **"change language."** Select the correct language for the ABPM model number. To accomplish this press the gray button above **"yes"** and continue to press this button until the correct language appears in the left hand corner.

For 5100-01, ENGLISH.

For 5100-02, GERMAN.

For 5100-03, SPANISH.

For 5100-04, ITALIAN.

For 5100-05, FRENCH.

To select the language press the green button.

2. After pressing the green button, the LCD screen should now read **"AM/PM."** At this point press the gray button above **"yes"** if the model number is 5100-01 or press the gray button above "no" for the other model numbers.

3. Press the green button until the unit reads **"auto dump."** Press the gray button above "on" and hit the green button.

4. The unit should now read **"1 day max."** Press the gray button above **"on"** and hit the green button.

5. The unit should now read **"exit."** Press the gray button above **"yes"** and the unit will go automatically into its resting main menu.

6. Press the green button until the unit reads **"set parameters."** Press the gray button above **"yes."** The unit should now read **"set periods."** Press the gray button above **"yes."** The unit should now read **"# of period."** Press the button above **"up"** until that statement reads **"# of periods 2."** Press the green button.

7. The LCD screen should now read **"prd 1"** with a cursor blinking at the starting hour. Press the gray button above **"up"** until the hour reads **"07 AM."** Press the green button and the cursor will move to the interval period. At this point press the gray button above **"up"** until the unit reads **"15m."** Hit the green button.

8. Do the exact same step as 16, except the hour needs to read **"11PM"** and the interval time must be **"30m."**

9. Hit the green button and the unit should now read **"maximum press."** Hit the gray button above **"up"** until that reading is **"200."** Press the green button.

10. The unit should read **"display."** Press the gray button above **"on"** and then press the green button.

11. The unit should now read **"start button."** Press the gray button above **"on"** then press the green button.

12. The unit will now read **"set adv param."** Press the gray button above **"yes."** The unit should read **"deflation rate."** Press the gray button above **"up"** until this reads **"3."** Press the green button.

13. The unit will now read **"set retry pram."** Press the gray button above **"yes."** The unit should now read **"reject sys >."** Press the gray button above **"up"** until this reading is **"250."** Press the green button.

14. The unit will read **" reject sys <."** Press the gray button above **"down"** until this reading is **"60."** Press the green button.

15. The unit should read **" rej sys chg >."** Press the gray button above **"up"** until this reading is **"150."** Press the green button.

16. The unit should read **" reject dia >."** Press the gray button above **"up"** until this reading is **"160."** Press the green button.

17. The unit will read **"reject dia <."** Press the gray button above **"down"** until this reading is **"30."** Press the green button.

18. The unit will read **"rej dia chg >."** Press the gray button above **"up"** until the reading is **"100."** Press the green button.

19. The unit will now read **"reject PP >."** Press the gray button above **"up"** until the reading is **"150."** Press the green button.

20. The unit should read **"reject PP <."** Press the gray button above down until the reading is **"10."** Press the green button.

21. Press the green button until the unit reads **"dynamic press."** Press the gray button above **"on"** then press the green button.

22. Go to **"erase data."** At this point press the button above **"yes."** The unit will ask **"are you sure,"** press the button above **"yes."**

CHAPTER 8:

Unit Service Procedures

Chapter 8: Unit Service Procedures

This chapter contains the procedures for servicing units that are functioning properly but require some form of software or hardware modification or recalibration.

NOTE: Effective March 1, 1995, the main PCB must be revision level C1 or higher, the power supply PCB must be revision level B or higher, the software must be revision level 2.60 (2.62 for Tenso24) or higher, and the unit housings must have metallized spray coating on majority of interior surface.

The following are the five service procedures currently performed on the ABPM:

1. **Installing New Unit Control Software (see Section 8.1)**
2. **Recalibrating The Unit Pressure Sensor (see Section 8.2)**
3. **Change Main PCB (see Section 8.3)**
4. **Change Power Supply PCB (see Section 8.4)**
5. **Change Unit Housings (see Section 8.5)**

Each of the corresponding sections in this chapter contains a detailed procedure of the servicing to be done along with all the hardware and software requirements needed for servicing the unit. Each section also contains the requirements that have to be met after servicing the unit and before returning it to the customer.

8.1 Installing New Unit Control Software

Service Description

The unit's EEPROM permanently stores the unit control software. The EEPROM data is stored with power supplied from the unit's lithium battery (which has a life span of 5 years). Due either to a failure of the lithium battery or data corruption from another source, the EEPROM may need be reloaded with unit control software. This procedure is also used to update unit's with modified control software that has come from product upgrades. This procedure erases the unit's EEPROM and loads in the latest version of the unit control software into the unit's EEPROM.

NOTE: Effective March 1, 1995, the software must be revision level 2.60 (2.62 for Tenso24) or higher. This level of unit software requires that the main PCB must be revision level C1 or higher.

NOTE: The software for the new valve ABPM must be 4.20 (4.21 for Tenso24) or higher.

NOTE: QuietTrak and Tenso24 models will have different software versions.

Hardware and Software Setup Required for Test

The test PC should be connected to the unit with the custom serial interface cable. In addition, a DC power supply needs to be connected to the breakout terminals 3 and 5. The unit control software and the PC test software (see Appendix 9.5) are both required for this test.

Test Procedure

1) Record the existing unit software version in the corresponding location (Existing Software Version) of the unit data sheet (see Appendix 9.1).

2) Remove power from the unit and then power the unit up.

3) Apply positive 12 VDC signal between breakout terminals 5 (+) and 3 (-). Electrically connect breakout terminals 3 and 4. NOTE: SOME NEW PCB UNITS MAY NOT REQUIRE THIS PROGRAMMING SIGNAL. NO HARM WILL OCCUR IF 12 VDC SIGNAL APPLIED TO THESE UNITS.

4) Start up the PC and go to the DOS prompt. Type "loadXXX" Then the serial number. (XXX is either 260 or 420 for QuietTrak or 262 or 421 for Tenso24)

5) WARNING: DO NOT DISTURB THE UNIT OR ATTACHED HARDWARE IN ANY MANNER WHILE SOFTWARE IS BEING LOADED - UNIT MAIN PCB WILL BE DESTROYED IF POWER OR ELECTRICAL CONNECTIONS ARE DISRUPTED DURING SOFTWARE LOADING.

6) Restart unit and confirm that the software version is correct. Record information on the units data sheet (see Appendix 9.1)

8.2 Recalibrating The Unit Pressure Sensor

Description

The unit's pressure sensor may drift out of product specifications over extended periods of use or from extreme condition operations. This procedure recalibrates the unit's pressure sensor at 0.0 mmHg and 150.0 mmHg by adjusting unit pressure sensor's zero and span potentiometers.

Hardware and Software Setup Required for Test

500cc volume, a pressure source, calibrated pressure meter, and a mini-flat head screwdriver are needed for this procedure.

Test Procedure

1) With the test setup described above, release any pressure from the unit and the 250 cc calibrated volume.

2) Power unit up into the "Detailed Tests" menu (see Appendix 9.4).

3) Select "Valve1Test" from menu selections. Unit valve should now close completely. NOTE: Pressure display will be in 0.1 mmHg units.

4) Remove external pressure from unit and check that calibrated pressure sensor reads 0.0 mmHg (+/- 0.25 mmHg).

5) Allow 5 seconds for unit to equalize. Check that external pressure is still 0.0 mmHg (+/- 0.3 mmHg). If not, repeat Step 4. If unable to equalize after a second attempt, perform diagnostic tests of internal and external pneumatics (see Sections 5.13 and 5.14).

6) Read unit pressure from unit's LCD display. Unit pressure should be 0.06 mmHg. If the unit pressure is different, perform Step 7. Otherwise, go to Step 8.

7) If unit has not already been opened, perform Step 1 of Appendix 9.2. Rotate the unit pressure sensor's zero potentiometer (the middle potentiometer (RP2) of the three potentiometers visible - refer to ABPM Assembly Drawing 125S205) until unit pressure is 0.06 mmHg. Perform diagnostic tests of internal pneumatics, pressure sensor, and main PCB board if unable to do this (see Sections 5.1, 5.3, and 5.13). This may require replacing pressure sensor on main PCB (See Section 6 of Appendix 9.3).

8) Adjust the unit and volume pressure upwards until calibrated pressure sensor reads 150.0 mmHg (+/- 1.5 mmHg).

9) Allow 5 seconds for volume to equalize. Check that pressure is still 150.0 mmHg (+/- 5 mmHg). If not, repeat Step 9. If unable to equalize after a second attempt, perform diagnostic tests of internal and external pneumatics (see Sections 5.13 and 5.14).

10) Read unit pressure displayed on unit LCD. The reading should be +/- 0.5 mmHg of the Setra meter reading. If the unit pressure is different, perform Step 11. Otherwise, go to Step 12.

11) If unit has not already been opened, perform Step 1 of Appendix 9.2. Rotate the unit pressure sensor's span potentiometer (potentiometer farthest to the left (RP3) of the three potentiometers visible, refer to ABPM Assembly Drawing 125S205) until unit pressure is within +/- 0.5 mmHg of calibrated pressure. Perform diagnostic tests of internal pneumatics, pressure sensor, and main PCB board if unable to do this (see Sections 5.1, 5.3, and 5.13).

12) Repeat Steps 4 through 11 until no unit pressure sensor potentiometer adjustments are necessary.

13) If unit has been opened, reassemble unit following Steps 43 through 46 of the reassembly procedure in Appendix 9.3.

14) Retest the unit with all tests specified in Chapter 7.

8.3 Upgrading Main PCB

Description

The unit's main printed circuit board (part 125S205) may not be the latest revision level. NOTE: EFFECTIVE MARCH 1, 1995, MAIN PCB REVISION LEVEL MUST BE C1 OR HIGHER.

Hardware and Software Setup Required for Test

None.

Test Procedure

1) Open up ABPM unit to the point that the main PCB's identification label is visible (follow disassembly procedure in Appendix 9.2). Using ABPM Part Drawing 125S205 as a guide, determine that the revision level of the PCB is C1 or higher.

2) If PCB is not up to date, replace following procedure in Appendix 9.3. This will require upgrading the unit software (see Section 8.1) and calibrating the new PCB's pressure sensor (see Section 8.2).

3) After all upgrades are complete, note all changes on unit data sheet and perform all unit testing specified in Chapter 7.

8.4 Upgrading Power Supply PCB

Description

The unit's main printed circuit board (part 125S206) may not be the latest revision level. NOTE: EFFECTIVE MARCH 1, 1995, POWER SUPPLY PCB REVISION LEVEL MUST BE B OR HIGHER.

Hardware and Software Setup Required for Test

None.

Test Procedure

1) Open up ABPM unit to the point that the power supply PCB's identification label is visible (follow disassembly procedure in Appendix 9.2). Using ABPM Part Drawing 125S206 as a guide, determine that the revision level of the PCB is C1 or higher.

2) If PCB is not up to date, replace following procedure in Appendix 9.3.

3) After all upgrades are complete, note all changes on unit data sheet and perform all unit testing specified in Chapter 7.

8.5 Upgrading Unit Housings

Description

The front, rear, and battery door molded ABS plastic housings should have a metallized spray coating on the majority of interior surfaces. If not, housings should be replaced with newer parts.

Hardware and Software Setup Required for Test

None.

NOTE: QuietTrak and Tenso24 models will have different front housing, rear housing, and battery door parts. See Appendix 9.6 for appropriate part numbers.

Test Procedure

1) Open up ABPM unit battery door. Examine perimeter of interior batter door around metal contact plate. There should be a small but visible band of silver metal spray coating. If not sure, open up unit enough to examine internal surface of rear (bottom) housing. Follow disassembly procedure in Appendix 9.2.

2) If housings do not have metallized coatings, replace all 3 housings (rear housing, front housing, and battery door) following procedure in Appendix 9.3. Be sure to use appropriate housing color for QuietTrak (black) and Tenso24(gray) units.

3) After all upgrades are complete, note all changes on unit data sheet and perform all unit testing specified in Chapter 7.

CHAPTER 9:

Appendices

Chapter 9: Appendices

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Appendix 9.1 Unit Repair/Service/Test Data Sheet

General Data

Repair/service date: _____

Test technician's name: _____

Unit's serial number: _____

Service Notes:

_____

_____

_____

_____

_____

_____

_____

_____

Service Data:

New software loaded (y/n) _____

Old software version _____

New software version _____

Serial number loaded _____

Recalibrate unit (y/n) _____

Initial 0 mmHg reading _____

Initial 150 mmHg reading _____

Repair Notes:

_____

_____

_____

_____

_____

_____

_____

_____

Repair Data:

Check all items repaired/replaced

Main PCB _____

Manifold _____

Microphone assembly _____

Control Valve _____ (serial number old/new)

Dump Valve _____ (serial number old/new)

Pump _____

Calibration _____

Serial Port _____

Microphone Port _____

Front Housing _____

Rear Housing _____

Power supply _____

LCD _____

Flat Cable (14 cond.) _____

Flat Cable (18 cond.) _____

Internal Pneumatics _____

Switch Array _____

Other Parts: _____

_____

_____

Test Data:

Technician	_____	
Test Date	_____	
Software	_____	
Serial Number	_____	
Inflation Time	_____	(<= 9.0 seconds)
Deflation Time	_____	(56.0 to 93.3 seconds)
Leak @ 250 mmHg	_____	(<= 7.5 mmHg)
Leak @ 50 mmHg	_____	(<= 7.5 mmHg)
Test pressure @ 250 mmHg	_____	(245 to 255 mmHg)
Unit pressure @ 250 mmHg	_____	(+/- 2.5 mmHg of test pressure)
Test pressure @ 150 mmHg	_____	(145 to 155 mmHg)
Unit pressure @ 150 mmHg	_____	(+/- 2.5 mmHg of test pressure)
Test pressure @ 50 mmHg	_____	(45 to 55 mmHg)
Unit pressure @ 50 mmHg	_____	(+/- 2.5 mmHg of test pressure)
Test pressure @ 0 mmHg	_____	(-0.3 to 0.3 mmHg)
Unit pressure @ 0 mmHg	_____	(+/- 2.5 mmHg of test pressure)
Test voltage 3.5 Vdc	_____	(3.48 to 3.52 Vdc)
Unit voltage 3.5 Vdc	_____	(+/- .15 Vdc of test voltage)
Pump time out fail-safe	_____	(64 to 96 seconds)
Overpressure value	_____	(291 mmHg to 310 mmHg)
Overpressure time out	_____	(192 to 288 seconds)
Pinched Tube Test	_____	(pass/fail)
Dump time	_____	(<= 5.5 seconds)
Asleep mode current	_____	(<= 9.3 mA)
Awake mode current	_____	(<= 60 mA)
Microphone test	_____	(pass/fail)
Print test	_____	(pass/fail)
LCD checked	_____	(yes/no)
Parameters loaded	_____	(yes/no)

Unit Pass/Fail _____

Appendix 9.2 Unit Disassembly Procedure

Refer to assembly drawings 124S536E (sheets 1-4) for all of the following procedures. Unit disassembly should only be performed by repair personnel who are familiar with the ABPM unit and this repair manual and have been certified for ABPM repair by the Tycos Instruments Quality Assurance Groups. Equipment needed to perform the following procedure is described in Chapter 2 and specified in Appendix 9.5. Certain unit components (manifold and LCD) must be discarded if they are removed during the disassembly process even if they are not previously faulty components. Avoid disassembling these items if unnecessary to complete repair of faulty component. The repair person should use the procedures below as guidelines for unit disassembly; certain steps can be omitted as determined by the repair personnel. **CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.**

9.2.1 Initial Opening Of The Unit

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

1. Invert assembly and remove (4) #2-28*.50 screws with T-8 torque driver from rear housing.

(Note: Housing can now be separated enough to perform internal pneumatic diagnostics.)

9.2.2 Completion Of Opening Of Unit

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

2. Remove battery housing door and spring and aside.

3. Remove tubing from the control valve.

4. Disconnect the serial port from the back of the main PCB using needle nose pliers.

5. Disconnect the pump tubing from the manifold.

6. Carefully disconnect pressure sensor tubing and dump valve tubing from manifold. **CAUTION: SUPPORT PRESSURE SENSOR WHILE PULLING TUBING FROM BARBED FITTING.**

7. Remove (1) #2-28*.31 screw with T-8 torque driver from manifold and gasket and aside manifold and screw. DISCARD GASKET.

(Note: Front and rear unit housings can now be laid open flat on the repair bench to enable diagnostic testing. The only connections between the two housings should be the two flex circuits.)

9.2.3 Complete Disassembly Of Rear (Main PCB) Housing

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

8. Remove pressure sensor tubing and tape from pressure sensor and main PCB (only if changing tubing).

9. Disconnect microphone receptacle Dupont connector from main PCB with needle nose pliers.

10. Remove main PCB from rear housing by removing (1) #2-56*.19 machine screw with Phillips driver.

11. Disconnect both (2) flex circuits from bottom of main PCB.

12. Remove microphone receptacle assembly from rear housing with 6 mm wrench (T112068A). Dupont connector will need to be clipped off (only do this if microphone receptacle or rear housing is being replaced).

(Note: Front and rear unit housings are now completely separated. Rear housing is completely disassembled with exception of lithium battery being attached to main PCB. See Section 8.3 for procedure.)

9.2.4 Complete Disassembly Of Front (Power Supply PCB) Housing

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

13. Disconnect pump Dupont connector from power supply PCB with needle nose pliers.

14. Untape pump tubing from battery housing cover and remove pump subassembly (remove pump tubing from pump if necessary).

15. Unsnap battery housing cover from battery housing by pressing in the two small tabs first and the single large tab and gently lifting up.

16. Remove serial port receptacle with 11 mm wrench (T112068A). Dupont connector will need to be clipped off (only do this if serial port receptacle or front housing is being replaced).

17. Remove battery housing from front housing by removing (2) 2-28*.31 screws with T-8 torque driver and (2) 0-40*.19 screws with T-5 torque driver.

18. Remove power supply PCB/battery housing/keypad/control valve assembly from front housing (will have to be wiggled out if serial port is still in place).

19. Unsolder battery contact springs from power supply PCB. DISCARD BATTERY CONTACT SPRINGS AFTER REMOVAL (Do this only if replacing power supply PCB).

20. Pull control valve off of power supply PCB.

21. Remove power supply PCB from battery housing by removing (1) 0-40*.19 screw from center of PCB with T-5 torque driver.

22. Remove keypad from power supply PCB.

23. Remove the control valve flex circuit from power supply. The control valve is now free of the power supply.

24. Remove flex circuit from power supply PCB.

25. Remove LCD and LCD window from front housing (both are attached with adhesive). Remove flex circuit from LCD module.

Appendix 9.3 Unit Reassembly Procedure

Refer to assembly drawings 124S536E (Sheets 1-4) for the following procedure. Unit reassembly should only be performed by repair personnel who are familiar with the ABPM unit and this repair manual and have been certified for ABPM repair by the Tycos Instruments Quality Assurance Group. Equipment needed to perform the following procedures is described in Chapter 2 and specified in Appendix 9.5. Certain unit components (manifold and LCD) must be new in order to be properly reassembled in the unit. All items replaced must be recorded on a unit data sheet (see Appendix 9.1) and maintained in the ABPM service center's records. The repair person should use the following procedures as guidelines for unit disassembly; certain reassembly steps can be omitted as determined by the repair personnel. **CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.**

9.3.1 Main Unit Reassembly

Initial Reassembly of Front Housing

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

1. If the front housing is already completely assembled, skip to Step 20. Otherwise, place battery housing open side down in T112066 nest.

2. Record power supply PCB number on unit data sheet (see Appendix 9.1).

3. Pre-bend straight flex circuit per print for power supply connection. Assemble power supply flex circuit to power supply PCB with conductive side up and shorter end toward PCB (see Assembly Drawing 124S536, Sheet 4). Close header to secure flex circuit with needle nose pliers alternating sides until header is completely closed. No contacts should be visible and flex circuit must exit straight out of header.

4. Insert the flex cable of the control valve (121S104) into its header. Close header to secure flex circuit with needle nose pliers alternating sides until header is completely closed. No contacts should be visible and flex circuit must exit straight out of header.

5. Position power supply PCB, component side down, onto battery housing, locating notch in end of PCB over post on housing.

6. Secure with (1) 0-40*.19 screw through center of PCB with T-5 torque driver. PCB must come flush with post.

7. Secure the control valve (121S104) at the end of the battery housing to the power supply PCB by removing the protective paper from the foam pads at the bottom of the valve. Place valve on to PCB with the serial number facing away from the battery housing.

8. Remove assembly from nest and position new battery contact springs through battery housing and power supply PCB locating first turn of spring in locating slots in housing. Replace assembly in nest and solder both leads to PCB pads. CAUTION: PROTECT EYES. Trim excess lead length.

9. Remove assembly from nest and position keypad to power supply PCB. Use T112067 tool to gently (DO NOT POKE HOLES IN POSTS) engage posts on array with holes in PCB. Keypad must lay flat on PCB.

LCD Replacement

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

10. If replacing LCD module and window, perform Steps 9 through 15. Otherwise, skip to Step 16.

11. Place front housing upside down in T112064 nest with LCD opening away from operator.

NOTE: QuietTrak and Tenso24 models will have different housing colors. See Appendix 9.6 for proper part numbers.

12. Clean inside surface of window flange with isopropanol on foam swab. Allow to dry.

13. Remove adhesive cover from face of replacement LCD window.

14. Orient LCD window with artwork upside down and facing away from operator. Position window centrally into front housing with top edge against locating bosses in housing and apply pressure around perimeter to seat securely. Top edge of window must contact locating bosses when seated. (window artwork may be low in front housing cutout).

15. Remove strip guard and adhesive cover from inside surface of LCD window. Position T112089 locator into front housing.

16. Remove protective cover from face of replacement LCD module and clean face of metal perimeter bezel with Isopropanol on cotton swab. Allow to dry. NOTE: DO NOT TOUCH CLEAR FACE OF UNPROTECTED LCD MODULE.

17. Orient LCD module upside down (extended side tabs down), position into front housing through locator and against locating bosses, and slide into position with face of module parallel to surface of LCD window. Top edge of module MUST be in contact with locating bosses in front housing when seated against window. NOTE: CHECK VISUALLY TO INSURE THIS CONDITION EXISTS. Remove and aside locator. Apply pressure to module perimeter to seat in window adhesive.

18. Remove front housing from nest and secure pre-bent LCD flex circuit (see 124S536E, Sheet 3) to connector on back of LCD module in front housing assembly, conductive side up, with shorter straight section oriented toward header. Close header to secure flex circuit with needle nose pliers alternating sides until header is completely closed. No contacts should be visible and flex circuit must exit straight out of header.

Completion Of Reassembly Of Front Housing

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

19. Position power supply PCB/battery housing/keypad/control valve assembly into front housing. Align assembly to position tabs to outside of LCD module and locate pushbuttons through openings in front housing. Trap all bends in LCD flex circuit except last two under battery housing.

20. Secure battery housing to front housing with (2) 2-28*.31 screws with T-8 torque driver and (2) 0-40*.19 screws with T-5 torque driver.

21. Remove front housing assembly from nest and aside nest to bench. Pass serial port receptacle assembly leads through opening in front housing from outside, align red index mark on receptacle toward top (button) surface of housing and insert receptacle between flats in hole. Position washer, ground lug (see ground lug subassembly procedure, Section 9.3.3) and nut (in that order) over leads to receptacle. Secure receptacle with nut leaving ground lug lead in the vertical position. Tighten nut securely with 11 mm wrench (T112068A). Bend ground lug 90 degrees over nut toward inside of housing in order to place ground lead with remainder of leads from receptacle. Insert conductors into Dupont connector according to Drawing 124S536, Sheet 4.

22. If there is no battery orientation label, apply battery orientation label (Part 45P3244) to battery housing cover per print. Label must not protrude over edge of cover.

23. Snap battery housing cover to battery housing, two small tabs first then single large tab.

24. Obtain pump subassembly and bend pump leads flat against end of pump housing. Connect pump Dupont connector to power supply PCB with needle nose pliers, for orientation see 124S536E, Sheet 2. Position pump assembly in front housing with square foam pads on ends of pump against locating bosses in housing. NOTE: INSURE THAT PUMP LEADS STAY FLAT AGAINST END OF PUMP HOUSING.

25. Loop the pump inlet tube up and over (and around the outlet tube and serial port leads) the pump housing and locate the tube so that it rests on the foam strips at each end of the pump and lays in the recess between the pump and the battery housing. The tube must not kink and must clear the battery door opening in the front housing. Loop a short length of tape at an angle around the inlet tube with the tape approximately centered between the foam strips. Secure the ends of the tape to the battery housing cover and the pump. The tube should be suspended and not make contact with the pump housing.

Rear Housing Reassembly

CAUTION: REPAIR PERSONNEL SHOULD USE PERSONAL GROUNDING STRAP AND GROUNDED BENCH MAT.

NOTE: QuietTrak and Tenso24 models will have different housing colors. See Appendix 9.6 for proper part numbers.

26. Pass microphone receptacle assembly leads through opening in rear housing from outside, align red index mark on receptacle away from pneumatic connector and insert receptacle between flats in hole. Position washer, ground lug (see ground lug subassembly procedure, Section 9.3.3) and nut (in that order) over leads to receptacle. Tighten nut finger tight and bend ground lug over nut hex point toward inside of unit parallel to connector housing and rotate to at least 9 o'clock position. Final tighten with 6 mm wrench (T112068) rotating the ground lug lead to a position between 6 and 9 o'clock (as viewed from the outside face of the unit). Insert conductors into Dupont connectors according to Drawing 124S536, Sheet 4.

27. If any of rubber bumpers on bottom of rear housing assembly are missing, replace with new ones using T112069. The crowned end flange of each bumper must be fully extended on the inside surface of the housing and the flat end should be out. **CAUTION: DO NOT PUNCTURE OR CUT BUMPER'S INSIDE FLANGE. REPLACE ANY BUMPERS DAMAGED IN ASSEMBLY.**

28. Position new manifold gasket into rear housing.

29. Take main PCB with assembled and insulated lithium battery (see lithium battery/main PCB subassembly procedure, Section 9.3.2) and dump valve and record serial numbers of main PCB and dump valve on unit repair sheet (Appendix 9.1). Secure flex circuits from front housing to connectors on bottom of main PCB with conductive side up. Close header to secure flex circuits with needle nose pliers alternating sides until header is completely closed. No contacts should be visible and flex circuits must exit straight out of headers.

30. Place the silicon tubing on to the dump valve and the pressure transducer according to drawing 124S536.

31. Position main PCB into rear housing and secure with (1) #2-56*.19 machine screw with Phillips driver. Connect both flex circuits according to print (see 124S536E, Sheets 2 and 3 if not connected already).

32. If not already connected, connect pressure sensor tubing to pressure sensor on main PCB, supporting back of pressure sensor during assembly. **CAUTION: DO NOT PINCH TUBE CLOSED IN ORDER TO AVOID APPLICATION OF AIR PRESSURE TO PRESSURE SENSOR.**

33. Connect microphone receptacle Dupont connector to main PCB with needle nose pliers per print (see 124S536E, Sheet 3) (white lead @ top left) and arrange wires against surface of main PCB.

34. Connect serial port Dupont connector to main PCB with needle nose pliers per print (see 124S536E, Sheet 3) . White lead should be at top left.

35. If not already connected, carefully connect pump and valve tubing to appropriate barbed manifold fittings.

36. If not already connected, assemble pressure sensor tubing to manifold, route tube around front of adjusting screw on forward pot and between square components on main PCB. Secure with short length of tape across square components.

37. Position manifold over gasket and secure with (1) #2-28*.31 screw with T-8 torque driver. Add adhesive to the screw threads before tightening all the way down. NOTE: TAKE CARE NOT TO DISLODGE PUMP.

38. Connect tubing to the control valve.

Completion Of Unit Reassembly

39. If required, recalibrate pressure sensor following procedure in Section 8.2 of this manual. It is also useful at this time to check if the unit leaks more than allowed (see Leak Testing in Chapter 7).

40. Position spring in battery door recess in front housing per print(see 124S536E, Sheet 1).
NOTE: QuietTrak and Tenso24 models will have different battery door colors. See Appendix 9.6 for proper part numbers.

41. Align front and rear housings, position battery door assembly and mate housings. Avoid crimping of wires, tubing or flex circuits. Insure that pressure sensor tubing is routed properly and not pinched.

42. Invert assembly and secure housings together with (4) #2-28*.50 screws with T-8 torque driver.

9.3.2 Lithium Battery/Main PCB Subassembly

CAUTION: USE GROUNDING STRAP.

1. Obtain lithium battery and check that voltage is nominally + 3 VDC. Clip negative (narrow) leg of battery adjacent to solder post so that leg is trimmed approximately flush with top of support radius (this is to avoid the leg shorting a trace on newest versions of PCB).

2. Remove main PCB from protective bag. Aside test data sheet for unit repair file. Position battery to PCB. INSURE THAT SHOULDERS OF THE BATTERY LEGS ARE FLUSH AGAINST TOP SURFACE OF PCB. Pull legs with tweezers to seat if required. Do not short legs of battery. Keep batteries in vendor-supplied trays. DO NOT dump into bin or pack in bulk.

3. Push wide leg away from PCB component and apply solder and iron to fill 1/2 of thru hole. Turn nest 180 degrees and solder narrow leg. Apply solder and iron to remaining half of wide leg to fill in hole. AVOID DAMAGE TO PCB COMPONENTS.

4. PROTECT EYES by placing finger over end of leg and trim excess length above solder joint with side cutters. Repeat for both legs. CLEAR CUT PIECES FROM SURFACE OF PCB.

5. Remove assembly from nest and apply insulating label 45P3257 to inside (+) face of battery.

9.3.3 Ground Lug Subassembly

1. Cut wire to approx. 3 inches. Repeat for quantity required.

2. Strip one end to approx. 0.125" (3 mm) and trim. Repeat for quantity required.

3. Terminate stripped end w/Dupont terminal. Repeat for quantity. required.

4. Trim lead to length from INSIDE end of terminal. Repeat for quantity required. Approx. 2.25" (57.2 mm) for serial port lug. Approx. 2.875" (73 mm)for mike port lug.

5. Strip end opposite terminal to approx. 0.125" (3 mm). Repeat for quantity required.

6. Secure ring terminal in vise with leg projecting forward and horizontal.

7. Tin lead w/iron tip, pass end of lead through hole in terminal leg and form hook in end of lead. Close hook w/needle nose pliers. Clip lead with fixture and adjust fixture T112063 arm to hold lead horizontal.

8. Solder lead to ring terminal and aside from vise.

9. Repeat steps 6 thru 8 for quantity required.

10. Cut heat shrink tubing to approx. 0.375" (9.5 mm) inch. Slip cut tubing over lead to cover solder joint and 1/2 to 3/4 of length of terminal leg. Shrink tubing w/heat gun @ 700 F. to envelope terminal tab and solder joint. KEEP PART MOVING and AVOID DAMAGE TO WIRE INSULATION.

9.3.4 Pump Subassembly

1. Remove any old foam from pump housing and clean surface with isopropanol.

2. Place template T112071 on port end of pump. Remove backing from strip and assemble around pump beginning at right edge of small indicator notch on perimeter of template. Position square pad to end of pump at cutout in template. Remove template and aside. Repeat strip and pad installation per print at opposite end (without use of template) aligning outside edge of foam strip to bottom of notches in metal pump housing. The square pad is to be placed approximately opposite the pad on the port end (remove plastic projections from end of pump housing with side cutters if required to mount pad).

9.3.5 Pressure Sensor Replacement on Main PCB

NOTE: This procedure is necessary when pressure sensor determined as failed or non-linear for product specifications.

1. Unsolder 114S589 from main PCB. Using a solder extractor with light back & forth motion (Not Circular!) on each pin remove the solder from the pressure sensor pins. The sensor should easily come out of the PCB. CAUTION: Excessive mechanical action on the pressure sensor while in the PCB will break the internal pad connections.

2. Solder in replacement 114S589 part to main PCB. Be careful not to damage 114S589 housing or to overheat component. Legs of 114S589 should be flush mounted with notch on Pin 1 leg of 114S589.

3. Connect a digital multimeter to pins 2 & 4 of the pressure sensor and adjust RP4 (right screw potentiometer on front of main PCB) until 0.00 VDC indicated.

4. Place the multimeter positive lead on J20 (see Drawing 125S205 for location) and the negative lead on pin 1 of the pressure sensor. With no external pressure applied, adjust RP3 (left screw potentiometer on front of main PCB) for an indication of 50mv.

5. Recalibrate pressure sensor per procedure in Section 8.1.

Appendix 9.4: Quick Guide To ABPM Operating Menus

This appendix is designed to be a quick reference to the ABPM unit operations and control software menus. For any detailed explanation or description, please consult the ABPM operator's manual (QuietTrak Operator's Manual) available from Tycos Instruments. The ABPM main unit is powered up by applying 6 VDC through its battery terminal housing (this can be accomplished with 4 AAA batteries or with the DC power supply and the custom battery insert described in Chapter 2). The four unit control program menus are listed below and described in short detail in the following sections:

1. **"Detailed Tests" Menu (see Section 9.4.1)**
2. **"Special Parameters" menu (see Section 9.4.2)**
3. **"Basic Parameters" menu (see Section 9.4.3)**
4. **"Advanced Parameters" menu (see Section 9.4.4)**

Three flow chart diagrams have been attached to assist with using the "Special Parameters", "Basic Parameters", and "Advanced Parameters" menus. See Chapter 3, pages 23-26 of the ABPM User's Manual.

9.4.1 "Detailed Tests" Menu

The "Detailed Tests" menu is not described in the ABPM operator's manual. The "Detailed Tests" menu allows for advanced diagnostics and is entered by depressing the two white buttons during power up. When the message "Detailed Tests?" appears, within one second release both white buttons and press the green button. When the message "Beginning Tests" appears release the green button. The "Detailed Tests" menu is then entered, with the first test question appearing on the LCD. The tests can be scrolled through by pressing the center gray ("No") button until the desired test appears. The left gray button ("Yes") key will activate the displayed test. The green button ("Exit") will exit the test mode. The following test commands are available from the "Detailed Tests" menu:

1. **"Valve 1 Test" Command (see Section 9.4.1.1)**
2. **"Valve 2 Test" Command (see Section 9.4.1.2)**
3. **"Valve 3 Test" Command (see Section 9.4.1.3)**
4. **"Deflation Test" Command (see Section 9.4.1.4)**
5. **"Printer Test" Command (see Section 9.4.1.5)**
6. **"Gain Test" Command (see Section 9.4.1.6)**
7. **"10 Bit AD Test" Command (see Section 9.4.1.7)**
8. **"Battery Test" Command (see Section 9.4.1.8)**
9. **"Default Test" Command (see Section 9.4.1.9)**
10. **"A Power U/D Test" Command (see Section 9.4.1.10)**
11. **"Ov Press Test" Command (see Section 9.4.1.11)**
12. **"POv Press Test" Command (see Section 9.4.1.12)**
13. **"Watchdog Test" Command (see Section 9.4.1.13)**
14. **"Reset Life Cnt" Command (see Section 9.4.1.14)**
15. **"Life Test" Command (see Section 9.4.1.15)**

The "Detailed Tests" menu is exited by pressing the "Exit" button whenever it is displayed outside of a test routine.

9.4.1.1. "Valve 1 Test" Command

Performs the following operations until the "Nxt" or "Exit" key is pressed: resets the unit's watchdog timer and fail-safe circuits, turns unit valve on (closed), and displays unit pressure (in 1/100's mmHg). Note: There will be no decimal point (.) display between 1's and 0.1's units of display.

9.4.1.2. "Valve 2 Test" Command

Performs the following operations until the "Exit" key is pressed: resets the unit's watchdog timer and fail-safe circuits, turns unit valve on, and displays valve count data. Valve count value can be increased with "Next" key or decreased with "Back" key. Increasing the valve count value opens the valve, decreasing the valve count value closes the valve.

9.4.1.3. "Valve 3 Test" Command

Performs the following operations until a key is pressed: resets the unit's watchdog timer and fail-safe circuits, turn valve hardware on/off, get current valve count data, and display valve count data. Same as "Valve 2 Test".

9.4.1.4. "Deflation Test" Command

Performs the following until a key is pressed: resets the unit's watchdog timer and fail-safe circuits, turns the valve hardware on/off, sets valve deflation rate, left button increments and right button decrements valve deflation rate counter with button presses, gets the current valve pressure, and displays the current valve pressure. '0002' is the slowest deflation value allowed.

9.4.1.5. "Printer Test" Command

This test sends a test pattern to the printer until the test is stopped manually. The pattern starts with one character on the first line, two on the second and so on. The space character is the first character sent. Upon reaching the eightieth line, the length of the line is set back to one and the pattern is restarted. This will take use about 11/3 pages of printer paper. The data character is not reset however, it is continuously incremented until reaching '~', then is reset to the space character. The speed at which the characters are sent is sufficient to over run the printer buffer, therefore testing the unit serial commands XOFF and XON. Clears unit output button.

9.4.1.6. "Gain Test" Command

Performs the following until a key is pressed: sets the unit's gains, displays the current unit's gains, and increments gains in response to user input. The '"KGUp" button raises the K Channel amplifier gain. The "DGUp" button raises the dynamic pressure channel amplifier gain.

9.4.1.7. "10 Bit A/D Test" Command

Performs the following until a key is pressed: checks A/D channel hardware, updates channel number of converter, gets current A/D channel signal, and displays current A/D channel signal. The "NxtC" button increments to the next channel when pressed. the "NxtT" button exits to the next test when pressed.

9.4.1.8. "Battery Test" Command

Performs the following until a key is pressed: gets the current battery voltage and displays the current battery voltage. The "NxtT" button exits to the next test when pressed.

9.4.1.9. "Default Test" Command

Performs the following unit a key is pressed: gets/saves the unit's RTC checksum value, increments the checksum value, displays the checksum value. The "NxtT" button exits to the next test when pressed. This command is useful for resetting the unit's valve synchronization word. This can be done by pressing the "NxtC" button more than once and restarting unit. Unit will now have to be cycled 3-5 times to reinitialize valve word.

9.4.1.10. "APower U/D Test" Command

Turns the 12 VDC power on and then off. Turns the unit analog power on and then off. The "NxtT" button exits to the next test when pressed.

9.4.1.11. "OvPress Test" Command

This test resets the unit watchdog timer and fail-safe circuits. Turns valve hardware on and turns motor on while "Yes" button is held. Displays current valve pressure data in 1/100's of mmHg. The pump will operate on and off when at 300 mmHg. The "NxtT" button exits to the next test when pressed.

9.4.1.12. "POvPress Test" Command

This test resets the unit watchdog timer and fail-safe circuits. Turns motor on and off and resets the unit watchdog timer. Unit valve is open during test. Displays current valve pressure data in 1/100's of mmHg. The "NxtT" button exits to the next test when pressed.

9.4.1.13. "Watchdog Test" Command

Performs the following until a key is pressed: resets the unit's watchdog timer and fail-safe circuit, turn valve hardware on/off, turn motor hardware on/off, wait 5 seconds and then end test.

9.4.1.14. "Reset Life Cnt" Command

Resets the life test cycle counter to 0. The "Reset" button resets the life cycle count to zero and is followed by confirmation buttons, "Yes" and "No".

9.4.1.15. "Life Test" Command

Performs the following unit a key is pressed: resets the unit's watchdog timer and fail-safe circuit's every 5 seconds, turns valve hardware on/off, turns motor hardware on, waits up to 10 minutes before ends test, turns motor hardware off. The "Stop" button stops the continuous cycle and responds with a "Yes" and "No" button display which respectively stops or continues the test.

9.4.2 "Special Parameters" menu

The "Special Parameters" menu allows for customizing the format and operation of the unit and is entered by depressing the left white button during power up. When the message "Change Languages?" appears, the "Special Parameters" menu is then entered. The menu can be scrolled through by pressing the right green button until the desired test appears. The following items are available from the "Special Parameters" menu"

1. **"Change Languages" Command (see Section 9.4.2.1)**
2. **"AM/PM" Command(see Section 9.4.2.2)**
3. **"Check Calib" Command(see Section 9.4.2.3)**
4. **"Auto Dump" Command(see Section 9.4.2.4)**
5. **"1 Day Max" Command(see Section 9.4.2.5)**

The "Special Parameters" menu is exited by pressing the "Yes" button when "Exit" is displayed. A flow chart of the "Special Parameters" operating menu is shown in Chapter 3, pages 23-26 of the ABPM User's Manual.

9.4.2.1 "Change Languages" Command

This specifies the language used in the monitor's display. Languages available are: English, Italian, French, Dutch, and Spanish.

9.4.2.2 "AM/PM" Command

Unit time can be represented in 12 hour am/pm time (Yes) or 24 hour time (No).

9.4.2.3 "Check Calib" Command

Displays the real-time values of the unit's pressure sensor (in mmHg) and the unit's microphone (in A/D counts).

9.4.2.4 "Auto Dump" Command

If Auto Dump feature is On, the cuff rapidly deflates at 20 mmHg below the observed Diastolic pressure. If Off, slow deflation continues until the cuff pressure is only 20 mmHg.

9.4.2.5 "1 Day Max" Command

If 1 Day Max feature is On, the unit will stop performing measurement cycles after 24 hours of operation.

9.4.3 "Basic Parameters/ Main Menu" menu

The "Basic Parameters/Main Menu" menu allows for basic setup and operation of the unit and is normally entered during power up. The menu can be scrolled through by pressing the right green button until the desired menu item appears. The following items are available from the "Basic Parameters" menu"

1. **"Resume Readings" Command(see Section 9.4.3.1)**
2. **"Review Data" Command(see Section 9.4.3.2)**
3. **"Print Data" Command(see Section 9.4.3.3)**
4. **"Erase Data" Command(see Section 9.4.3.4)**
5. **"Set Patient ID" Command(see Section 9.4.3.5)**
6. **"Set Date" Command(see Section 9.4.3.6)**
7. **"Set Time" Command(see Section 9.4.3.7)**
8. **"Set Parameters" Command(see Section 9.4.3.8)**
9. **"Do Office Run" Command(see Section 9.4.3.9)**
10. **"Begin Reg Runs" Command(see Section 9.4.3.10)**

A flow chart of the "Basic Parameters" operating menu is shown in Chapter 3, pages 23-26 of the ABPM User's Manual.

9.4.3.1. "Resume Readings" Command

This message will appear if a 24-hour monitoring period has been interrupted. Most often this would occur if a patient removes the batteries, or opens and closes the battery door during the 24 hour monitoring period. This message will be displayed for one minute. If no commands are made, the unit will automatically resume the monitoring period. If "No" button is pressed, the unit quits the monitoring interval.

9.4.3.2. "Review Data" Command

This menu item is only displayed if the unit has performed one or more measuring cycles. When pressed, the unit displays the patient data.

9.4.3.3. "Print Data" Command

This menu item is only displayed if the unit has performed one or more measuring cycles. When pressed, the unit prints the patient data through the unit's serial port to an externally connected printer.

9.4.3.4. "Erase Data " Command

This menu item is only displayed if the unit has performed one or more measuring cycles. When pressed, the unit erases the patient data from RAM.

9.4.3.5. "Set Patient ID" Command

This menu item allows for modifying the 9 character patient identification number.

9.4.3.6. "Set Date" Command

This menu item allows for modifying the unit's date.

9.4.3.7. "Set Time" Command

This menu item allows for modifying the unit's time.

9.4.3.8. "Set Parameters" Command

This menu item allows for entering the following unit parameters: measurement intervals (periods), maximum inflation pressure (max press), display status, and start button status. This menu item also allows the user to enter the advanced parameters menu.

Using the "Set Periods" selection, the number of measurement intervals can be specified (up to 4). The start time and length (in 15 minute sections) is then entered for each designated interval. The "Maximum Press" selection allows the for the unit's maximum inflation pressure to be set between 160 mmHg and 270 mmHg (in 10 mmHg intervals). The "Display" status allows for the unit display to be turned on or off during monitoring intervals. The start button status allows for the unit's user to activate unit measurement cycles during the monitoring interval by pressing the "start" button. For information on the "Advanced Parameters" menu, go to Section 9.4.4.

9.4.3.9. "Do Office Run" Command

This menu selection will display the number of measuring runs performed and will also allow for starting a unit measurement cycle. When the "Start" key (right green button) is pressed, the unit will autozero and then start the unit's pump and perform the actual measurement.

9.4.3.10. "Begin Reg Runs" Command

This menu selection allows the initiation of a preprogrammed monitoring interval.

9.4.4 "Advanced Parameters" Menu

The "Advanced Parameters" menu allows for customizing the format and operation of the unit and is entered through the "Set Advanced Parameters" command of the "Basic Parameters/Main Menu" menu. The following items are available from the "Special Parameters" menu"

1. **Deflation Rate (see Section 9.4.4.1)**
2. **Set Retry Parameters (see Section 9.4.42)**
3. **Dynamic Pressure (see Section 9.4.4.3)**

The "Advanced Parameters" menu is exited by pressing the "Next" button when "Set Adv Params:" is displayed. A flow chart of the Advanced Parameters" operating menu is shown in Chapter 3, pages 23-26 of the ABPM User's Manual.

9.4.4.1 Deflation Rate

Sets the units deflation rate during the measurement cycle. "Up" and "Down" button options allow user to increment and decrement inflation rate. Options are 3, 4 , 5, and 6 mmHg per second rates.

9.4.4.2 Set Retry Parameters

Sets the minimum, maximum, and maximum change limits for the systolic and diastolic pressures measured by the unit. It also sets the minimum and maximum pulse pressure limits for the unit. Selection buttons allow for "Yes" and "No". The unit will retry a measurement cycle during a monitoring interval if one of these limits is exceeded.

9.4.4.3 Dynamic Pressure

If this selection is turned on, the unit will only inflate to 30 mmHg greater than the last systolic pressure recorded during a monitoring interval. Selection buttons allow for "On" and "Off". If off, the unit will always inflate to the designated maximum pressure.

Appendix 9.5 Specifications For ABPM Test and Repair Equipment

9.5.1 Pressure Sensor

* 0-315 mmHg measuring range
* 0.1 mmHg resolution
* 0.1% full scale accuracy
* Automatic temperature compensating circuitry
* Compatible output (either digital display or linear Volt)

Recommended equipment: Setra 270-5G
Note: This recommended sensor requires a regulated 24 VDC power supply (Section 9.6.5).

9.5.2 Calibrated Timer (Stopwatch/Digital Timer)

* Resolution: 0.01 seconds
* Range: 48 hours
* Accuracy: +/- 0.05 seconds

Recommended equipment: "Timer" command available with PC testing software (see Section 9.5)

9.5.3 Calibrated Adjustable Isolated Power Supply

* Adjustable Voltage, range 0-6.5 VDC
* Output current level up to 1 amp at 6 V
* Voltage output must be regulated and isolated from earth ground
* 10 mV resolution
* Optional: Output voltage and current display

(Hewlett Packard E3611A - $300)

9.5.4 Custom Battery Insert

* Per Tycos Drawing #T112372 or equivalent function.

(Tycos Tool #T112372)

9.5.5 Calibrated Voltage and Current Measurement Device

(Multimeter/Oscilloscope)

* 0-15V input
* 0-500 mA input
* 0.1 mV Voltage resolution
* 0.05 mV Voltage accuracy on 5 Volt reading
* 1 mA current resolution
* 5 mA current accuracy resolution on 500 mA reading

(Hewlett Packard 3468B)

9.5.6 Personal Computer

* IBM AT compatible
* 25 MHz (Intel 386 or better) microprocessor
* 2 MB RAM
* 40 MB hard disk storage
* 3.5 1.44 MB floppy disk drive
* Serial port
* Mouse and mouse port
* Keyboard
* VGA graphics and color monitor
* DOS 4.0 operating system or higher

(Dell 325SX, Windows 3.1)

9.5.7 Custom Serial Communication Cable

* Per Tycos Drawing #T112371

(Tycos Tool #T112371)

9.5.8 Calibrated 100cc, 250cc, and 500cc Volumes

* T-112818, T-112819, and T-112854
* Accuracy greater than +/- 5.0 cc
* Leaks less than 0.5 mmHg/minute

(Available from Tycos, T numbers listed above.)

9.5.9 High Pressure Source With Valve

* Range 0-350 mmHg
* Valve leaks less than 1mmHg/minute with valve closed

(Bulb with Checkvalve Available from Tycos Instruments, Part #5088-01))

9.5.10 Pneumatic Hosing

* Flexible material (latex, silicon, polyurethane)
* 0.125" inner diameter
* 5 - 3" pieces, 1 - 2", 4", 15", and 10" piece
* Leaks less than 0.1 mmHg/minute at 300 mmHg

(Available from Tycos Instruments part # 97P24)

9.5.11 Pneumatic 'T' and 'Y' Connector

* 0.125" mm inner diameter
* less than 3 cm per leg
* Leaks less than 0.1 mmHg/minute at 300 mmHg

(Available from Tycos Instruments)

9.5.12 Miniature Flat Head Screwdriver

* blade tip width approximately 1 mm

(Available from Tycos Instruments)

9.5.13 Grounded Bench Mat with Personal Grounding Strap

*** Mat surface and personal grounding strap resistance to ground < 10 Ohms**
(Available from Tycos Instruments)

(Repair Equipment)

9.5.14 Torque Limiting Driver - #2-28 Driver with T8 Torque Bit

*** Torque driver bit size #2-28**
*** Torque limit at 2 in-lb.**
(Available from Tycos Instruments T112467)

9.5.15 Torque Limiting Driver - #2-56 Driver with Phillips Bit (Tool #243-C)

*** Torque driver bit size #2-56**
*** Torque limit at 2 in-lb.**
(Available from Tycos Instruments T112466)

9.5.16 Torque Limiting Driver - #2-56 Driver with Phillips Bit (Tool #243-C)

*** Torque driver bit size #2-56**
*** Torque limit at 2 in-lb.**
(Available from Tycos Instruments T112459)

9.5.17 Front Housing Nest (Tool #T112064)

*** Per Tycos Drawing #T112064**
(Tycos Tool #T112064)

9.5.18 Front Housing Locator (Tool #T112089)

*** Per Tycos Drawing #T112089**
(Tycos Tool #T112089)

9.5.19 Battery Housing Nest (Tool #T112066)

*** Per Tycos Drawing #T112066**
(Tycos Tool #T112066)

9.5.20 Keypad Post Engaging Tool (Tool #T112067)

*** Per Tycos Drawing #T112067**
(Tycos Tool #T112067)

9.5.21 Serial Port Assembly 11 mm Wrench (Tool #T112068A)

*** Wrench with 11 mm hex head**
(Available from Tycos Instruments)

9.5.22 Bumper Installation Tool (Tool #T112069)

* Tool must have tapered probe head
(Wera Scnellform - 1020S)

9.5.23 Microphone Port Assembly 6 mm Wrench (Tool #T112068)

* Wrench with 6 mm hex head
(Available from Tycos Instruments)

9.5.24 Cutting Tools (Diagonal Cutters and Scissors)

* sufficient to cut small gauge wires completely
* sufficient to cut 0.75 cm diameter latex tubing cleanly
* used to cut double-sided adhesive tape

9.5.25 Needle Nose Pliers

* pliers tip width approximately 1 mm
* electro-statically protected

9.5.26 Foam Swabs (Tycos Part #318M2)

* Must be visibly free of foreign materials
(Available from Tycos Instruments)

9.5.27 Tweezers

* Used to remove labels and adhesive backings.

Appendix 9.6 List Of ABPM Replacement Parts

Unit parts, subassemblies, and accessories of the ABPM unit needed for stock of a repair/service center. Provided with the list are the recommended quantity to stock and unit of measure.:

PART NUMBER	DESCRIPTION	U/M	QUANTITY
1) 114P81	Battery, 15 V AAA (German Size Micro AM4)	PK(4Batts)	30
2) 5100-30	Microphone and Pneumatic As	EA	15
3) 95P336E	Patient Diary, English	EA	15
4) 95P337E	Manual, English	EA	15
5) 95P338E	Card, Owner Reg	EA	15
6) 5100-52	Medium inflation bladder	EA	15
7) 5100-53	Large inflation bladder	EA	15
8) 5100-38	Medium cuff	EA	15
9) 5100-37	Large cuff	EA	15
10) R35S676(X)	QuietTrak Rear housing ass. (black color, label (X): E-English, F-French, I-Italian, S-Spanish, G-German)	EA	5 E, 1 each of F,I,S,G
11) R3S608	Battery door assembly	EA	20
12) R168S102	Pump	EA	20
13) R45P3257	Label, battery insulator	EA	15
14) R11P1234	Spring, battery contact	EA	25
15) R66S508	Serial Port Receptacle Assembly	EA	20
16) R430E132	Tygon tubing	FT	55
17) R121S103	Dump Valve	EA	15
18) R121S104	Control Valve	EA	15
19) R66S507	Microphone Receptacle Assembly	EA	20
20) R116S179	LCD module	EA	15
21) R114P82	Battery, lithium	EA	15
22) R74P100	Switch array	EA	15
23) R66S505	Flat cable - 6 inch 14 cond	EA	25
24) R66S510	Flat Cable - 6 inch 18 cond	EA	25
25) R66P801	Connector, Dupont, 6-pin	EA	50
26) R59P585	Bumpers	EA	45
27) R43P821	Gasket, manifold	EA	25
28) R35P1357	QuietTrak Housing, front (black)	EA	15
29) R35P1353	Housing, battery	EA	15
30) R35P1352	Housing - battery cover	EA	15
31) R11P1235	Spring - battery door	EA	15
32) R9P2458	2-56 x .188 screw	EA	15
33) R9P2849	2-28 x .50 screw	EA	45
34) R9P2842	2-28 x .312 screw	EA	35
35) R9P2841	0-40 x .188 screw	EA	35
36) R4P436	Manifold	EA	15
37) R45P3244	Battery label	EA	15
38) R125S206	Power supply PCB (>= Rev. B)	EA	15
39) R125S205	Main PCB (>= Rev. C1)	EA	15
40) R34P767	LCD Window	EA	15
41) 265E388	Black wire	FT	100
42) 430E135	Shrink tubing	FT	4
43) R78P564	Foam pad	EA	40
44) R78P565	Foam disc	EA	40
45) R78P566	Foam Strip	EA	40

46) R113P461	Small grd. lug	EA	20
47) R113P462	Large grd. lug	EA	20
48) R35P1365G	Tenso24 Rear Housing (gray)	EA	5
49) R35P1357G	Tenso24 Front Housing (gray)	EA	5
50) R55-70-930	Tenso24 Battery Accu-pac Mount	EA	5
51) R114S589	Pressure Sensor (on Main PCB)	EA	5

ACCESSORY ITEMS

ACCESSORIES	DESCRIPTION	U/M	QUANTITY
1) 5100-41	Patient Hook up kit		
2) 5100-41E	(English)	PACK OF 25	1
3) 5100-41F	(French)	PACK OF 25	1
4) 5100-41G	(German)	PACK OF 25	1
5) 5100-41I	(Italian)	PACK OF 25	1
6) 5100-41S	(Spanish)	PACK OF 25	1
7) 5100-42	Patient Diary		
8) 5100-42E	(English)	PACK OF 50	1
9) 5100-42F	(French)	PACK OF 50	1
10) 5100-42G	(German)	PACK OF 50	1
11) 5100-42I	(Italian)	PACK OF 50	1
12) 5100-42S	(Spanish)	PACK OF 50	1
13) 5100-43	Microphone anchors	PACK OF 50	1
14) 5100-44	Cuff anchors	PACK OF 50	1
15) 5100-45	Anchoring straps	EA	5
16) 5100-46	Carrying pouch	EA	5
17) 5100-47	Waist belt	EA	5
18) 5100-48	Shoulder strap	EA	5
19) 5100-49	T-Connector	EA	15
20) 5100-30	Micro/pneum tubing as	EA	5
21) 5100-31	Large cuff/pneum. as	EA	5
22) 5100-32	Medium cuff/pneum as	EA	5
23) 5100-33	Small cuff/ pneum. as	EA	5
24) 5100-34	Large cuff and bladder	EA	10
25) 5100-35	Med. cuff and bladder	EA	10
26) 5100-36	Small cuff and bladder	EA	10
27) 5100-37	Large cuff	EA	10
28) 5100-38	Medium Cuff	EA	10
29) 5100-39	Small cuff	EA	10
30) 5100-51	Small bladder	EA	10
31) 5100-52	Medium bladder	EA	10
32) 5100-53	Large bladder	EA	10
33) 5100-25	PC Cable	EA	15
34) 5100-22	Printer Cable	EA	15
35) 5100-6X	PC Diskette SW	EA	5

* ACCESSORY items are packaged for sale to customers also.

All of the above parts can be ordered from Tycos Instruments.

Appendix 9.7 List of Relevant ABPM Documents

The following is the list of relevant ABPM documents:

1. **QuietTrak (ABPM) Operator's Manual (Tycos Part # 95P337E)**
2. **ABPM Hardware Specification**
3. **ABPM Software Specification**
4. **ABPM Serial Communication Specification**
5. **ABPM Main Board Test Specification**
6. **ABPM Power Supply Board Test Specification**
7. **ABPM Repair Test Specifications 126P171**

Contact the Engineering Department of Tycos Instruments to obtain any of the above documents.

Appendix 9.8 List of ABPM Assembly Schematics

The following is the list of ABPM assembly drawings that should be included with this manual:

1. **Drawing #66S533, 1 Sheet, Microphone and Pneumatic Assembly**
2. **Drawing #66S504, 1 Sheet, Computer to CR Unit Cable**
3. **Drawing #66S506, 1 Sheet, Printer to CR Unit Cable**
4. **Drawing #66S507, 1 Sheet, Microphone Receptacle Cable**
5. **Drawing #66S508, 1 Sheet, Printer Receptacle Cable**
6. **Drawing #66S512, 1 Sheet, Microphone and Pneumatic SA**
7. **Drawing #124S536*, 4 Sheets, CR Unit ABPM**
8. **Drawing #121S103, 1 Sheet, Dump Valve**
9. **Drawing #121S104, 1 Sheet, Control Valve**
10. **Drawing #168S102, 1 Sheet, Pump Subassembly**
11. **Drawing #125S205, 1 Sheet, ABPM Main PCB Assembly Drawing and Bill of Materials**
12. **Drawing #109P375, 1 Sheet, ABPM Main PCB Schematic**
13. **Drawing #125S206, 1 Sheet, ABPM Power Supply PCB Assembly and Bill of Material**
14. **Drawing #109P376, 1 Sheet, ABPM Power Supply PCB Board Schematic**

    *** These drawings are issued as one document describing five different language QuietTrak versions (E, G, F, I, and S) and the Tenso24 unit (K).**

Contact the Engineering Department of Tycos Instruments if any of the above drawings are missing or out of date.

Bill of Materials

ITEM	QTY	REFERENCE	VALUE/DESCRIPTION	MFG/MFG #	ALTERNATES	DECAL
1	1	BT1	3V Lithium	Panasonic BR2330-1VC1		BT1
2	3	C1,C5,C25	1.5UF/10V Tant 20%	AVX/KYOCERA TAJA155M016R		SMDTCA
3	4	C2,C3,C12,C13	.1uF 10% X7R 50V 10%	AVX/KYOCERA 12065C104KATM		SMD1206
4	1	C4	2700pF X7R 50V 10%	AVX/KYOCERA 08055C272KATM		SMD805
5	2	C6,C73	.01uF X7R 50V 10%	AVX/KYOCERA 08055C103KATM		SMD805
6	3	C7,C24,C52	.018uF X7R 50V 10%	AVX/KYOCERA 08055C183KATM		SMD805
7	6	C16,C20,C35,C210,C211, C212	100uF/6V TANT 6V 10%	AVX/KYOCERA TAJD107K006R		SMDTC2
8	4	C18,C48,C55,C97	10uF/16V TANT 16V 10%	AVX/KYOCERA TAJC106K016R	TAJC106K010R	SMDTC1
9	24	C19,C34,C54,C71,C72,C76, C77,C80,C82,C83,C84,C85, C88,C89,C90,C92,C95,C96, C98,C205,C206,C207,C208, C213	.1uF Z5U 50V 20%	T&B/VITRAMON VJ0805U104MXAMT		SMD805
10	1	C23	.12uF 5% XR7 50V 5%	AVX/KYOCERA 12105C124JATM		SMD1210
11	1	C27	.15uF 5% XR7 50V 5%	AVX/KYOCERA 12105C154JATM		SMD1210
12	2	C51,C209	.033uF X7R 50V 10%	AVX/KYOCERA 08055C333KATM		SMD805
13	2	C60,C59	5.6V 5.6V TVS	AVX/KYOCERA VC0805056150R		SMD805
14	2	C75,C74	10pF NP0 100V 10%	AVX/KYOCERA 08051A100KATM		SMD805
15	1	C78	4.7uF/16V Tant 10%	AVX/KYOCERA TAJC475K016R		SMDTC1
16	2	C81,C79	4.7uF/10V Tant 20%	AVX/KYOCERA TAJB475M010R		SMD3528
17	4	C200,C201,C202,C203	1UF/16V Tant 10%	AVX/KYOCERA TAJA105K016R		SMDTCA
18	4	D8,D9,D10,D11	10MQ090 90V Schottky	Intl Rect. 10MQ090		D-64
19	2	D12,D13	MMBD1203.HIGH DUAL 100V 100MA	National MMBD1203.HIGH		WAC_SOT-23_3
20	2	FID1,FID2	FIDUCIAL local target	SMEMA Standard 3.1 1991		FID
21	2	J3,J6	HEADER 6R RA 2mm 2x3	DuPont 86453-306		DUP_86453-X06
22	1	J5	HEADER 14 1mm x 14 RA 0.3mmFFC	Molex 52207-1490		MOL_52207-1490
23	60	J11,J20,J21,J22,J25,J26, J27,J28,J29,J30,J31,J32, J33,J34,J35,J36,J37,J38, J39,J41,J42,J43,J44,J45, J46,J47,J48,J49,J50,J51, J53,J54,J55,J56,J57,J59, J60,J61,J62,J63,J64,J65, J66,J67,J68,J69,J70,J71, J72,J73,J74,J75,J76,J77, J78,J79,J80,J81,J82,J83	HEADER 1 through-hole test point	n/a n/a		TP40

ITEM	QTY	REFERENCE	VALUE/DESCRIPTION	MFG/MFG #	ALTERNATES	DECAL
24	1	J40	HEADER 18 1mm x 18 RA 0.3mmFFC	Molex 52207-1890		MOL_52207 1890
25	1	J52	HEADER 3 Header 2mm x 3 RA	DuPont/Berg 69309-003	Samtec TMM-103-01-L-S-RA	DUP_69309-003
26	1	J58	SMD-TP Test Point, SMD	n/a n/a		SMD-TP
27	1	K1	LATCHVALVE Pneumatic Valve	tbd tbd		DIP10
28	2	N9,N4	NODE n/a	n/a NODE		SMDNODE
29	1	PS1	TRANSDUCER SXO5 W/fitting	Sensym SX05DP1		PS1
30	2	Q2,Q6	VP0610T 60V P-Channel	Siliconix VP0610T-T1		WAC_SOT-23_3
31	2	Q3,Q25	2N7002 60V N-Channel	Siliconix 2N7002T1		WAC_SOT-23_3
32	1	Q26	MMBT4403 PNP 600MA	Motorola MMBT4403LT1		WAC_SOT-23_3
33	1	Q27	MMBT3904 NPN SMD	Motorola MMBT3904LT1		WAC_SOT-23_3
34	1	RN1	100 K 2% Network	CTS 766-141104GTR07		SO14
35	1	RP1	5K 1T 1 Turn 20%	Philips ST-4T B502		ST-4P
36	3	RP2,RP3,RP4	20K 14T 14 TURN 10%	Philips ST-5T P203	BOURNS 3269P-1-203	ST-5P
37	4	R1,R2,R3,R32	75K 1% 1/10W	KOA RK73H2AT7502F		SMD805
38	4	R4,R7,R182,R186	150K 1% 1/10W	KOA RK73H2AT1503F		SMD805
39	1	R5	11K 1% 1/10W	KOA RK73H2AT1102F		SMD805
40	21	R6,R34,R36,R38,R39,R44, R66,R72,R79,R84,R85,R89, R150,R151,R152,R153,R154, R172,R181,R188,R189	100K 1% 1/10W	KOA RK73H2AT1003F		SMD805
41	3	R8,R115,R187	249 1% 1/10W	KOA RK73H2AT2490F		SMD805
42	4	R9,R54,R62,R179	499K 1% 1/10W	KOA RK73H2AT4993F		SMD805
43	1	R10	6.81K 1% 1/10W	KOA RK73H2AT6811F		SMD805
44	1	R31	6.19K 1% 1/10W	KOA RK73H2AT6191F		SMD805
45	1	R33	4.22K 1% 1/10W	KOA RK73H2AT4221F		SMD805
46	1	R35	110K 1% 1/10W	KOA RK73H2AT1103F		SMD805
47	2	R37,R65	9.53K 1% 1/10W	KOA RK73H2AT9531F		SMD805
48	4	R40,R63,R170,R175	24.9K 1% 1/10W	KOA RK73H2AT2492F		SMD805
49	3	R41,R73,R156	42.2K 1% 1/10W	KOA RK73H2AT4222F		SMD805
50	5	R42,R43,R75,R77,R83	100.0K 0.1% 1/8W	KOA RN73E2BT1003B		SMD1206
51	2	R46,R185	1.74K 1% 1/10W	KOA RK73H2AT1741F		SMD805
52	1	R47	2.21K 1% 1/10W	KOA RK73H2AT2211F		SMD805

ITEM	QTY	REFERENCE	VALUE/DESCRIPTION	MFG/MFG #	ALTERNATES	DECAL
53	8	R48,R60,R81,R82,R90,R171, R173,R184	10K 1% 1/10W	KOA RK73H2AT1002F		SMD805
54	1	R49	12.4K 1% 1/10W	KOA RK73H2AT1242F		SMD805
55	2	R50,R180	332K 1% 1/10W	KOA RK73H2AT3323F		SMD805
56	1	R51	1.24K 1% 1/10W	KOA RK73H2AT1241F		SMD805
57	3	R53,R87,R118	1M 1% 1/10W	KOA RK73H2AT1004F		SMD805
58	1	R64	309K 1% 1/10W	KOA RK73H2AT3093F		SMD805
59	1	R71	10M 1% 1/8W	KOA RK73H2BT1005F		SMD1206
60	2	R74,R76	37.40K 0.1% 1/8W	KOA RN73E2BT3742B		SMD1206
61	2	R80,R155	37.4K 1% 1/10W	KOA RK73H2AT3742F		SMD805
62	5	R86,R176,R177,R178,R183	54.9K 1% 1/10W	KOA RK73H2AT5492F		SMD805
63	1	R110	1K 1% 1/10W	KOA RK73H2AT1001F		SMD805
64	1	R123	8.06M 1% 1/8W	KOA RK73H2BT8064F		SMD1206
65	2	R162,R163	20K 1% 1/10W	KOA RK73H2AT2002F		SMD805
66	2	R164,R174	200K 1% 1/10W	KOA RK73H2AT2003F		SMD805
67	3	U2,U11,U14	TLE2022 Dual Op-Amp	TI TLE2022CD		SO8
68	1	U9	Z80180F 8-bit uP	Zilog Z8018008FSC		FP-80B
69	1	U10	LT1101S Instru. Amp	Linear Tech LT1101S		SO16W
70	1	U12	LT1079S Quad Op-Amp	Linear Tech LT1079S		SO16W
71	1	U13	LM334 T Sense/I Source	Linear Tech LM334S8		SO8
72	1	U16	74AC04 Hex Inverter	National 74AC04SC	Harris CD74AC04M Motorola MC74AC04DR2	SO14
73	1	U19	MAX186DC 12-bit Serial A/D	Maxim MAX186DCAP	Maxim -CCAP, -BCAP, -ACAP, -_EAP	SSO20
74	1	U20	29F010 Flash 128Kx8 5V	AMD AM29F010-120JC	also -90JC and -70JC	PLCC32
75	1	U21	DS1284Q RTC/WD/BBU RAM	Dallas DS1284Q		PLCC28
76	2	U22,U39	TLC339 Qual LP Comp	TI TLC339CD		SO14
77	2	U23,U25	74HC4060 Binary Counter	Harris CD74HC4060M	National MM74HC4060MX	SO16
78	1	U24	74HC74 Dual D F-F	Harris CD74HC74M	National MM74HC74AM, Philips 74HC74D, Motorola MC74HC74ADR2	SO14
79	1	U26	DS1267S-100 Dual DigPot	Dallas DS1267S-100		SO16W
80	1	U27	DS1610S NV Controller	Dallas DS1610S		SO16W
81	3	U28,U33,U38	74AC11 Triple 3-AND	National 74AC11SC	Motorola MC74AC11D	SO14
82	1	U29	82C55A PIO	Harris CS82C55A		PLCC44

ITEM	QTY	REFERENCE	VALUE/DESCRIPTION	MFG/MFG #	ALTERNATES	DECAL
83	1	U30	74AC139 Dual 2-4 Decoder	Harris CD74AC139M	Motorola MC74AC139DR2	SO16
84	1	U31	74AC138 3-8 Line Decoder	Harris CD74AC138M		SO16
85	1	U32	TC55257 SRAM	Toshiba TC55257DFL-85L	Sony CXK58257AM-10L	SOP32W
86	1	U34	LM385M Active Zener	National LM385M		SO8
87	1	U35	LT1280 Dual LP 5V RS232	Linear Tech LT1280CS		SO18W
88	1	U37	TLC1078 Dual Op-Amp	TI TLC1078CD		SO8
89	1	X1	12.288MHZ 50PPM	CTS MP122SM	MTron ATS-49 RXD MP494 Fox HC49S	XTAL200
90	1	X2	32.768KHZ Clock Xtal 20ppM/6pF	Dallas DS9032	Daiwa/KDS DT26S, DT38 Seiko DS-VT-200 FOX NC26-32.768	FX-3_H

Bill of Materials

ITEM	QTY	REFERENCE	VALUE/DESCRIPTION	MFG/MFG #	ALTERNATES	DECAL
1	1	C314	100uF/6V TANT 6V 10%	AVX/KYOCERA TAJD107K006R		SMDTC2
2	7	C315,C330,C332,C338,C342 C343,C504	.1uF Z5U 50V 20%	T&B/VITRAMON VJ0805U104MXAMT		SMD805
3	7	C329,C336,C337,C339,C344 C345, C346	100uF TANT 6V 10%	AVX/KYOCERA TAJD107K006R		SMDTC2
4	2	C333, C505	10uF/16V 1.5 Ohm ESR 16V 20%	Nichicon F941C106MCG	See sheet 1	SMDTC1
5	1	C358	10pF NP0 100V 10%	AVX/KYOCERA 08051A100KATM		SMD805
6	1	C506	OPT0805 n/a	n/a n/a	(FOR LAYOUT ONLY)	SMD805
7	1	D301	MMBD1203.HIGH DUAL 100V 100MA	National MMBD1203.HIGH		WAC_SOT_ 23_3
8	2	D310,D309	10MQ090 90V Schottky	Intl Rect. 10MQ090		D-64
9	2	FID1,FID2	FIDUCIAL local target	SMEMA Standard 3.1 1991	(FOR LAYOUT ONLY)	FID
10	1	J300	HEADER 18 1mm x 18 RA 0.6mmFFC	Molex 52207-1890		MOL_52207-1890
11	1	J301	BAT CONTACT n/a	n/a n/a		conn2-490
12	1	J302	HEADER 2 RA 2mm x 2, latching	DuPont 78186-002		J4
13	1	J303	HEADER 6 1mm x 6 RA 0.3mmFPC	Molex 52207-0690		MOL_52207-0690
14	32	J334,J338,J339,J340,J341, J342,J343,J344,J345,J346, J347,J348,J349,J350,J351, J352,J353,J354,J355,J356, J357,J358,J359,J360,J361, J362,J363,J364,J365,J366, J367,J368	HEADER 1 through-hole	n/a n/a	(FOR LAYOUT ONLY)	TP40
15	2	L301,L302	220uH 10% Delevan#1812-224K	RCD MCI-1812-220UH-KT		SMD1812
16	1	L303	220uH/60ma 10%	Dale IS-21-22OUH		IS-22CHOKE
17	1	L305	300uH 15%	Renco 9652		SM45
18	5	N5,N7,N10,N11,N14	NODE n/a	n/a NODE	(FOR LAYOUT ONLY)	SMDNODE
19	3	Q303,O304,Q324	SMD25N05-45L 50V .045 Logic Level	Siliconix SMD25N05-45L		WAC_TO-252_3
20	6	O320,Q321,O322,Q329,Q330 Q331	VP0610T 60V P-Channel	Siliconix VP0610T-T1		WAC_SOT-23_3
21	4	Q325,O326,Q327,O328	MMBT4403 PNP 600MA	Motorola MMBT4403LT1		WAC_SOT-23_3
22	2	O332,Q333	SI9955 50V .13 Dual N Chan	Siliconix SI9955DY		SO8

ITEM	QTY	REFERENCE	VALUE/DESCRIPTION	MFG/MFG #	ALTERNATES	DECAL
23	2	Q334,Q335	MUN2211 NPN BRT 10K	Motorola MUN2211T1		WAC_SC-59_3
24	2.	R355,R473	392K 1% 1/10W	KOA RK73H2AT3923F		SMD805
25	4	R356,R361,R414,R474	100K 1% 1/10W	KOA RK73H2AT1003F		SMD805
26	1	R357	68.1K 1% 1/10W	KOA RK73H2AT6812F		SMD805
27	5	R358,R359,R480,R484,R486	10K 1% 1/10W	KOA RK73H2AT1002F		SMD805
28	2	R369,R479	61.9K 1% 1/10W	KOA RK73H2AT6192F		SMD805
29	4	R378,R413,R481,R482	2.21K 1% 1/10W	KOA RK73H 2AT2211F		SMD805
30	1	R412	1M 1% 1/10W	KOA RK73H2AT1004F		SMD805
31	1	R416	6.81K 1% 1/10W	KOA RK73H2AT6811F		SMD805
32	4	R475,R476,R477,R478	150 1% 1/10W	KOA RK73H2AT1500F		SMD805
33	2	R483,R485	3.09K 1% 1/10W	KOA RK73H2AT3091F		SMD805
34	1	R487	1K 1% 1/10W	KOA RK73H2AT1001F		SMD805
35	1	S301	YES White	320-.02E1-1-.08-WHT ECG		SW-CONTACT
36	1	S302	START/STOP Green	320-.02E1-1-.08-GRN ECG		SW-CONTACT
37	1	S303	No White	320-.02E1-1-.08-WHT ECG		SW-CONTACT
38	1	U315	RC4190 Switch Regulator	Raytheon RC4190M		SO8
39	1	U317	ICL7660 Voltage Converter	Maxim ICL7660CSA		SO8
40	1	U318	TLC352 Dual L.P. Comp. O.C.	TI TLC352CD		SO8
41	1	U319	LT1129CQ LDO 700MA	Linear Tech LT1129CQ		WAC_DD_5T